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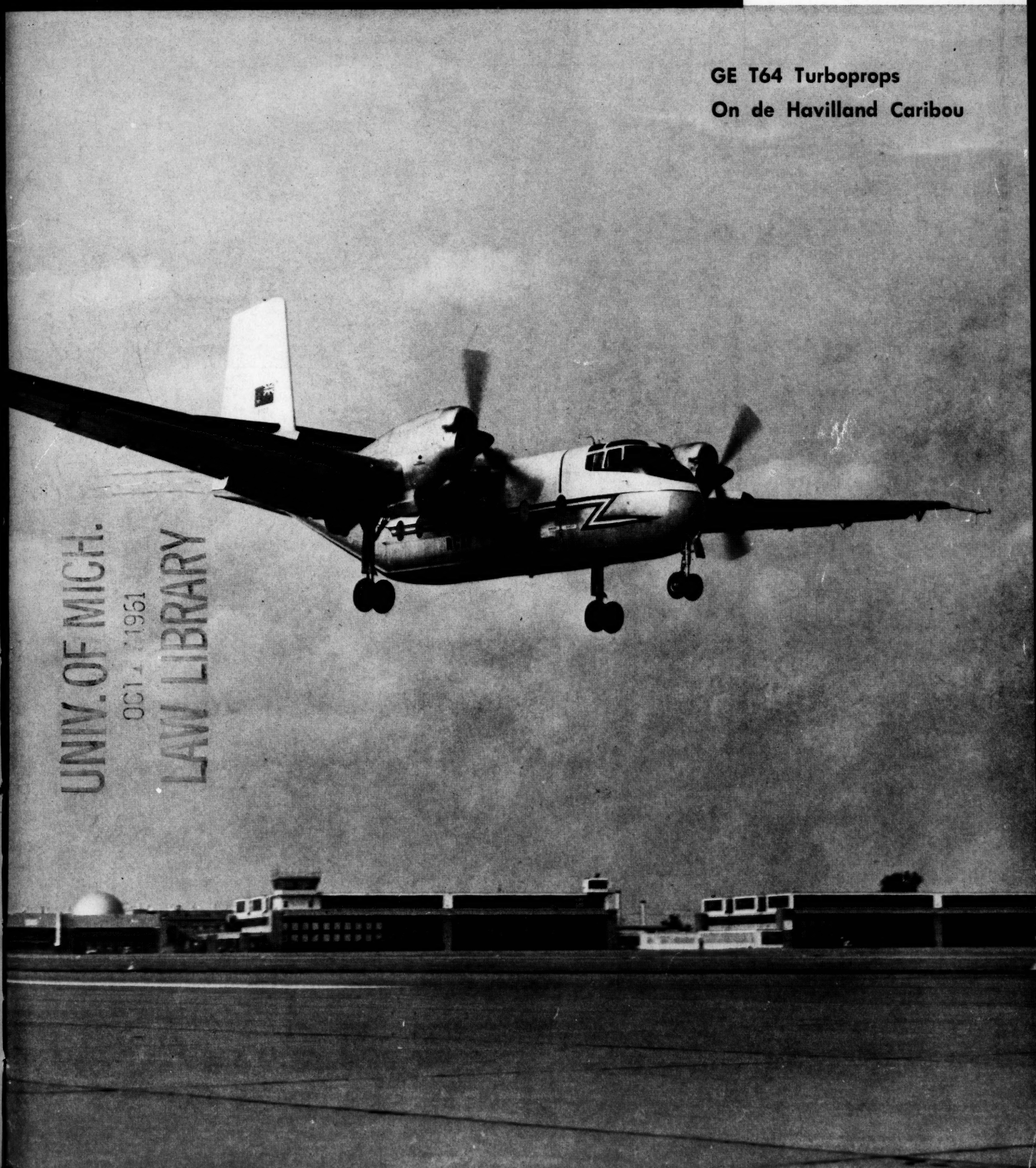
October 16, 1961

Aviation Week and Space Technology

Special Report, Photos of ARS Display, Meeting



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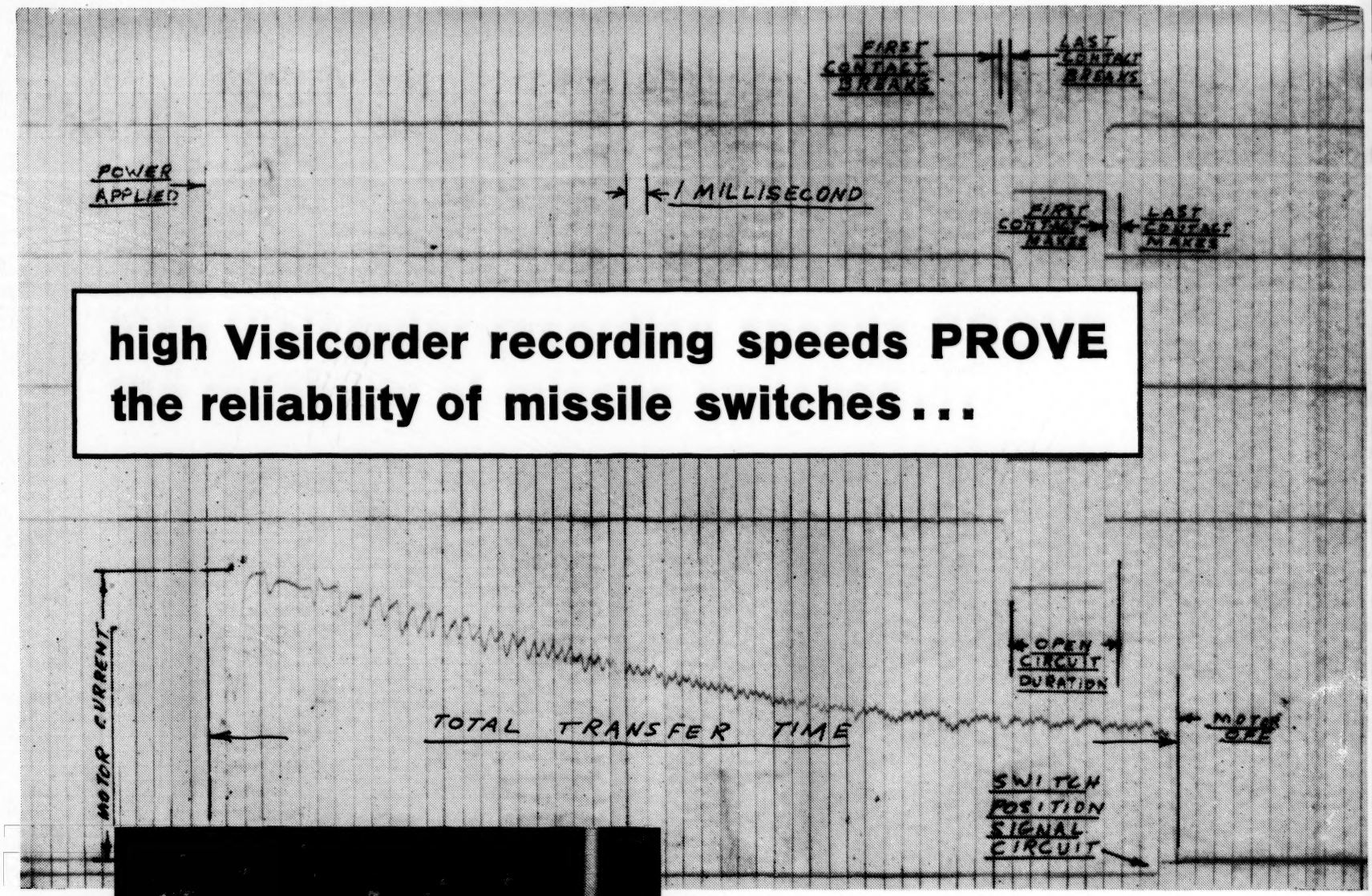

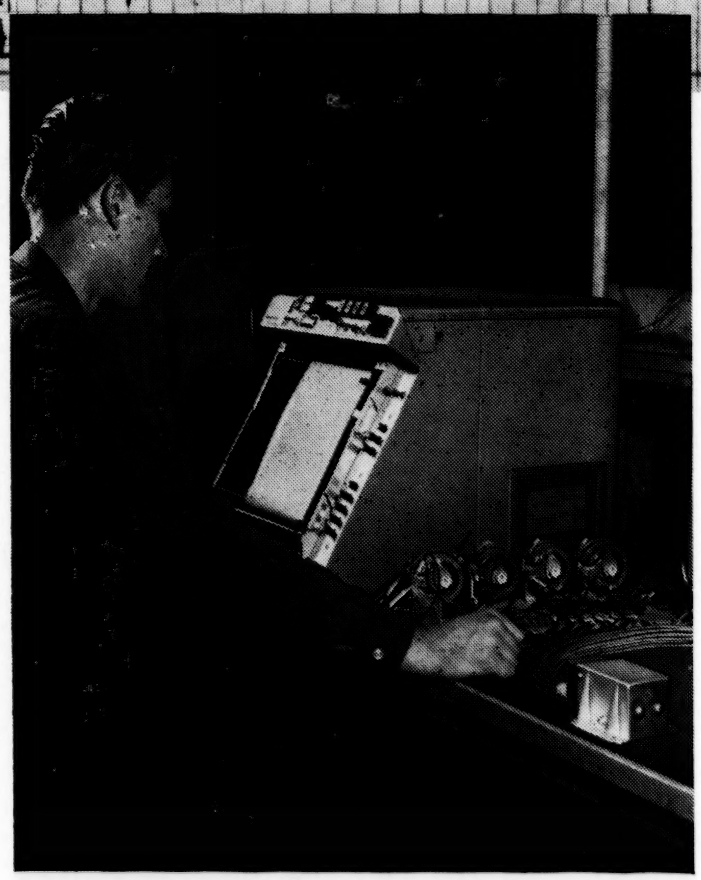

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AVIATION CALENDAR

Oct. 23-24—Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Canada.

Oct. 23-24—International Airline Navigators Council, European Regional Meeting, Paris, France.

Oct. 23-25—East Coast Conference on Aerospace and Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 23-27—17th Annual General Meeting, International Air Transport Assn., Sydney.

Oct. 23-Nov. 3—William Tell 1961, USAF Interceptor Weapons Meet, Tyndall AFB, Fla. Host: Air Defense Command.

Oct. 24-26—Air Traffic Conference, Air Transport Assn., Marriott Twin Bridges Motor Hotel, Washington, D. C.

Oct. 24-26—International Symposium on Aero-Space Nuclear Propulsion, IRE, Riviera Hotel, Las Vegas, Nev.

Oct. 24-26—Air Transport Assn.'s Engineering and Maintenance Operators Meeting, Americana Hotel, Miami Beach, Fla.

Oct. 25-27—Annual Convention, Southeastern Airport Managers' Assn., Penn Hotel, Monroe, La.

Oct. 25-27—Joint Electronics Division-Pacific Coast Regional Meeting, American Ceramic Society, Jack Tar Hotel, San Francisco, Calif.

Oct. 26-27—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Sahara Hotel, Las Vegas, Nev.

Oct. 26-27—Third Annual Symposium on High-Speed Testing, Hotel Somerset,

(Continued on page 6)

VIATION WEEK and Space Technology

October 16, 1961

Vol. 75, No. 16

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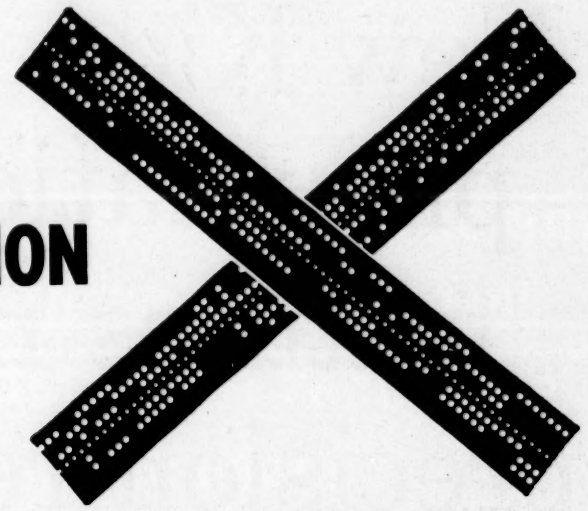

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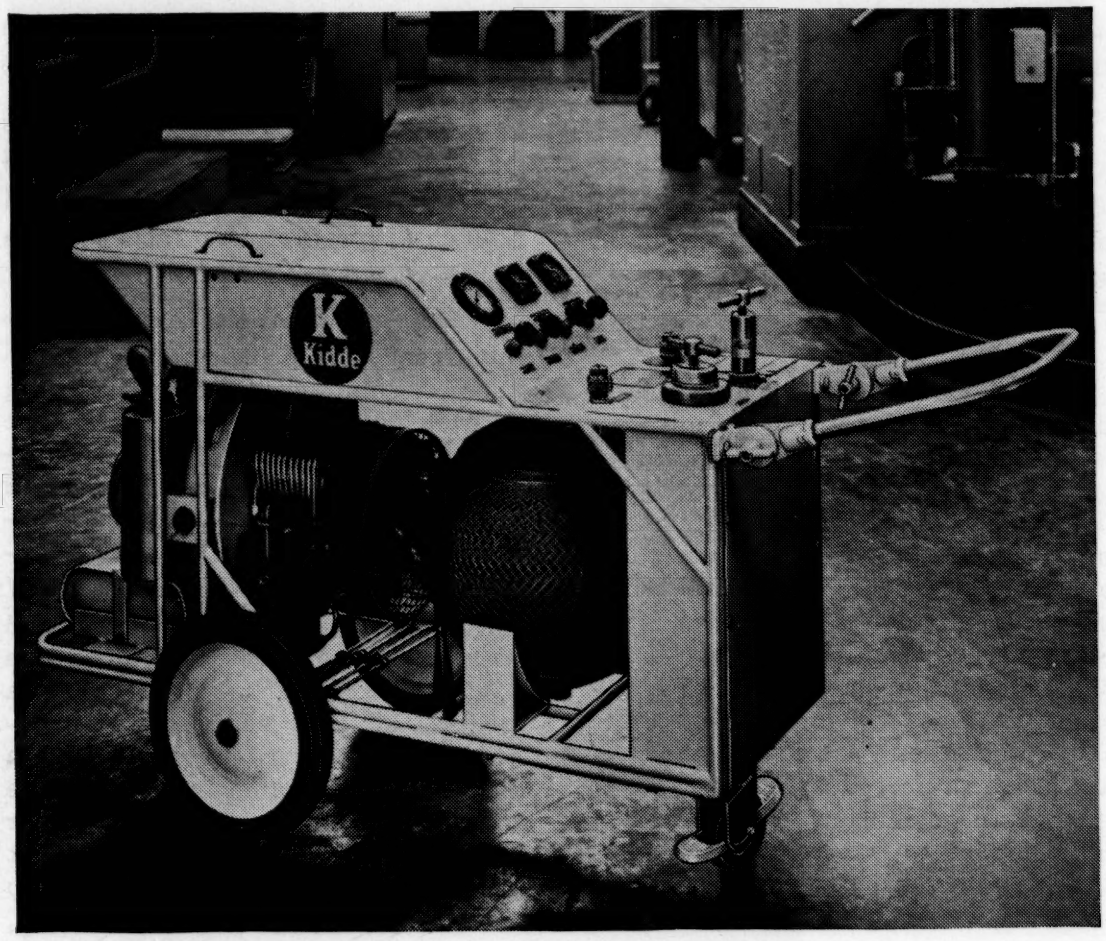

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AVIATION CALENDAR

(*Continued from page 5*)

Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

Oct. 26-28—Electron Devices Meeting, Institute of Radio Engineers, Sheraton-Park Hotel, Washington, D. C.

Oct. 29-31—International Symposium on Photoelasticity, Illinois Institute of Technology, Chicago, Ill.

Oct. 30-31—Aero/Space Fluid Power Conference, Pick-Fort Shelby Hotel, Detroit, Mich. Sponsor: Aero Hydraulics Division of Vickers, Inc.

Oct. 30-Nov. 1—Annual Meeting, Air Traffic Control Assn., Deauville Hotel, Miami Beach, Fla.

Oct. 30-Nov. 1—Technical Symposium on Aerothermoelasticity, Biltmore Hotel, Dayton, Ohio. Sponsor: Aeronautical Systems Division, Air Force Systems Command.

Oct. 31-Nov. 2—Fall Meeting, Radio Technical Commission for Aeronautics, Washington Hotel, Washington, D.C.

Nov. 1-3—First International Congress on Experimental Mechanics, Society for Experimental Stress Analysis, Hotel New Yorker, New York, N. Y.

Nov. 1-3—"Issues and Challenges of Air Transportation" Symposium, Hartford, Conn. Sponsor: Connecticut General Life Insurance Co.

Nov. 6-8—Special Technical Conference on Non-Linear Magnetics, Institute of Radio Engineers, Statler Hilton Hotel, Los Angeles, Calif.

Nov. 6-9—1961 Conference and AtomFair, Atomic Industrial Forum and American Nuclear Society, Conrad Hilton Hotel, Chicago, Ill.

Nov. 7-9—Seventh Conference, Radio Interference Reduction and Electronic Compatibility, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill.

Nov. 9-10—Fifth Annual Display, Aerospace Electrical Society of San Diego, Balboa Park, San Diego, Calif.

Nov. 9-10—11th National Conference, Aircraft and Missiles Division, American Society for Quality Control, Ambassador Hotel, Los Angeles, Calif.

Nov. 13-14—Electrically Exploded Wire Conference, Kenmore Hotel, Boston, Mass. Sponsor: Thermal Radiation Laboratory, Geophysics Research Directorate, AF Cambridge Research Laboratories.

Nov. 14—Symposium on Electronic Systems Reliability, Institute of Radio Engineers, Kansas City, Mo.

Nov. 14-16—Northeast Electronics Research and Engineering Meeting, Institute of Radio Engineers, Commonwealth Armory and Somerset Hotel, Boston, Mass.

Nov. 19-24—Medical and Biological Problems in Space Flight Conference, Nassau, Bahamas.

Nov. 28-30—38th Meeting, Aviation Distributors and Manufacturers Assn., Jung Hotel, New Orleans, La.

Nov. 30-Dec. 1—12th National Conference, Institute of Radio Engineers' Professional Group on Vehicular Communications, Radison Hotel, Minneapolis, Minn.

Dec. 5-7—Annual Convention, National Aviation Trades Assn., Statler Hilton Hotel, Washington, D. C.

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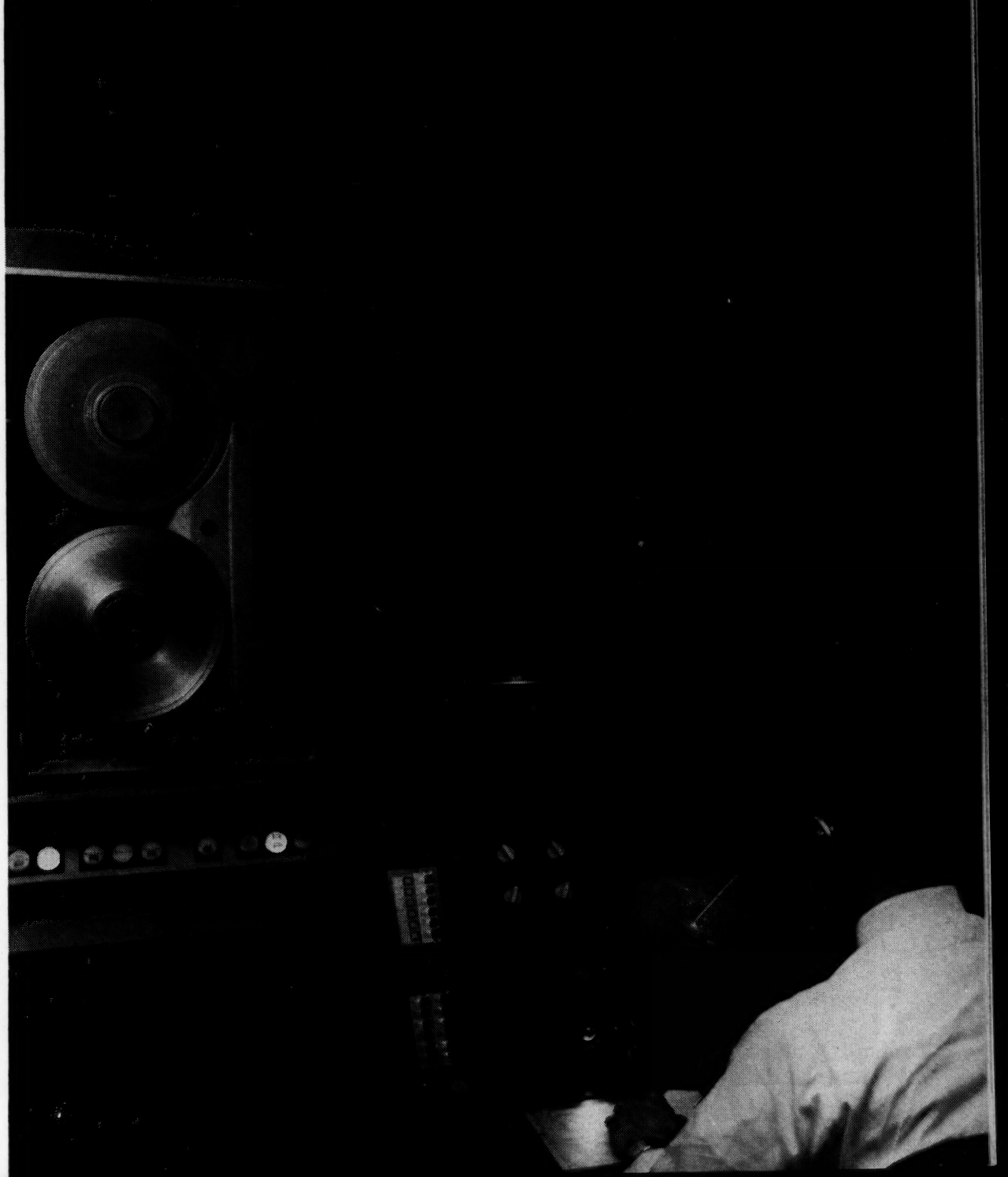

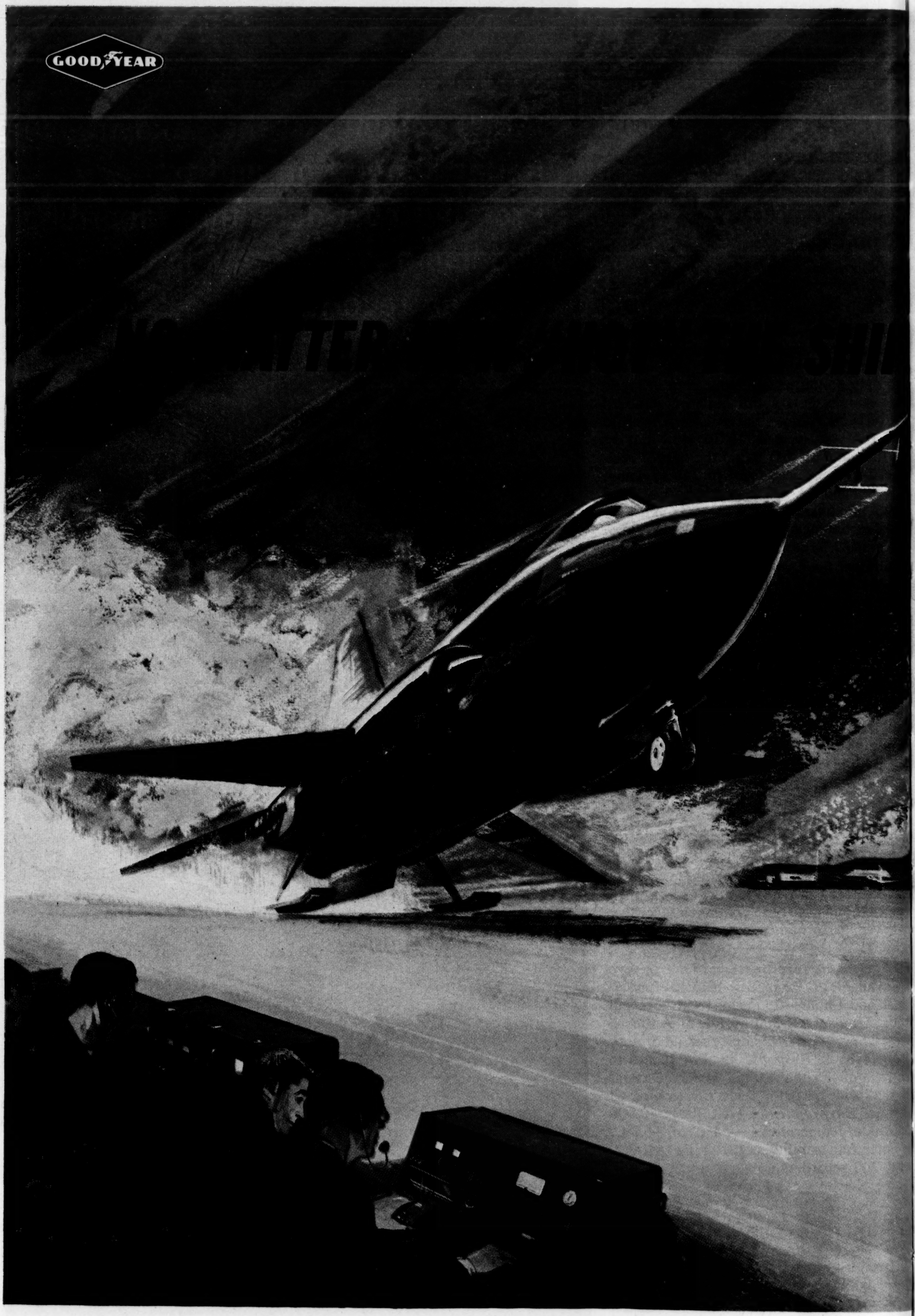
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ARS Underscores U.S. Space Goals, Gaps 27
▶ New York exhibit indicates nation's ambitions, but timetable for major achievements hinges on boosters.

Delta Sees Added Potential in New Routes 36
▶ Increased space activities on Delta's southern transcontinental routes may enhance carrier's position.

Beech Drone Nears Service Tests 52
▶ Mach 2 high- and low-altitude missile target has completed contractor tests; modified engine planned for later models.

SPACE TECHNOLOGY
Finned Saturn, Boosters at ARS..... 26
ARS Underscores Space Goals..... 27
Space Designs Shown at ARS..... 30
X-15 Reaches 215,000 Ft..... 32
Comsat Launches Slated for 1962.... 33
West Ford Approved After Study..... 35
Cut in Ranger's Components Studied.. 91

MISSILE ENGINEERING
AEC to Expand Pluto Test Site..... 32
Zeus Destroyed on 2nd Test..... 32
Beech Drone Nears Service Tests..... 52
Nitrogen Conversion, Storage System. 59
Rotary Motor for Booster Control.... 65

AERONAUTICAL ENGINEERING
A-Bombs May Control Hurricanes.... 32
Vickers Hovercraft Nears Test..... 108
Skid Computer Derived From B-70.... 113
Kaman HU2K-1s Fly Formation..... 115

AVIONICS
ACCESS Shows Newest Data Link Ideas 99
Filter Center 105

BUSINESS FLYING
Turbine Executive Aircraft Gaining... 73
Southwest Airmotive Sales Drop..... 81
Czechs Designing New Lightplanes... 83
Private Lines 87
Production Briefing 88

AIR TRANSPORT
Delta Sees Potential in New Routes... 36
Lack of Liaison Cause of BOAC Strike. 39
Liquidation Ordered for British Carrier 39
Airlines Split on Dropping Frills..... 40
Northwest Combines Customer Services 40
London City Heliports Opposed..... 41
Canada Sues for Navigation Fees.... 41
National Reports $7-Million Loss..... 41
ALPA to Press Wider Picketing Rights 43
Pyle to Leave FAA for Industry..... 43
Stranded Charter Stirs Ire in Congress 45
Hughes, Atlas Extend Northeast Talks 50
Airline Traffic—July, 1961..... 51
Shortlines 47
Airline Observer 47

MANAGEMENT
Unified SAC-Polaris Command Proposed 34
Who's Where 23
Industry Observer 23
Washington Roundup 25
News Digest 35

SAFETY
Viscount Crash Icing Discrepancy Cited 117

Calendar 5
Letters 136

EDITORIAL
Education's Role in Space 21

COVER: General Electric T64 turboprop engines are flight-tested for the first time on Sept. 22 as the powerplants of a de Havilland of Canada Caribou STOL transport. Royal Canadian Air Force Caribou flew to an altitude of 12,000 ft. and was airborne for one hour. The test was rated "completely satisfactory" by General Electric and de Havilland.

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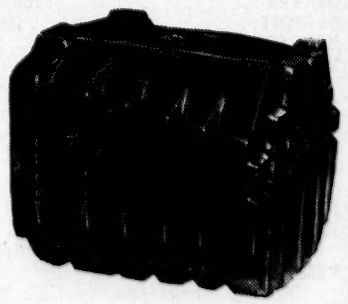

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EDITORIAL

Education's Role in Space

Dr. James A. Van Allen, head of the physics department at the State University of Iowa and discoverer of the earth's radiation belts, told the American Rocket Society's Space Flight Report to the nation last week that there is a "great chasm" between the nation's ambitions in space and its competence to fulfill them. He also suggested some solutions. Because of the importance of Dr. Van Allen's remarks to the national space effort, AVIATION WEEK *is publishing the text of his speech.*

If an unbiased, intelligent person (from Mars, let us say) were to survey the program of our current Space Flight Report to the Nation, he would be entitled to the impression that the space program of the United States is primarily in the hands of the agencies of the federal government and of large industrial establishments—and that universities play a minor and perhaps peripheral role in this great enterprise.

This impression would also be gained from an examination of the programs of other major engineering societies. And indeed, in the sense of the practitioner, this impression contains a large measure of truth. It is therefore proper to inquire whether the colleges and universities of our country do have a vital role in space science and technology. I believe that the answer to this inquiry is affirmative, but I do not consider that this answer is altogether obvious. Hence my remark.

First, let me note that the educational system—and in particular that component of it which recalls higher education—provides the essential intellectual parenthood for most scholarly, scientific and technological activities of any culture.

We witness today what I regard as, "the great chasm" in our space program. We are aware on a daily basis of an immense enthusiasm and interest in space exploration by the youngsters of the nation and by the general public. This may perhaps be summarized by saying that we have immense and rapidly growing ambitions in the field of space exploration, both manned and unmanned. Yet, we must confess to a level of over-all competence which is far short of these ambitions.

There are many brilliant achievements in this field. Yet there is, from a scholar's point of view, a striking paucity of solid, fundamental literature in the field and a similar lack of treatises on basic aspects of the subject. One is acutely aware of this when he undertakes to provide an interested group of students with a reading list which will carry them from the rudiments of the subject to a level of genuine understanding—from which understanding original contributions of a substantial sort may be expected to emerge.

Moreover, many practitioners exhibit only the most superficial familiarity with the literature which does exist.

In short, our national ambitions have greatly outrun our national competence. We can doubtless continue to muddle along in this style in a more or less creditable way for awhile—especially since our international competition suffers from the same malady. But in due course, our efforts will become less and less imaginative and resourceful and more and more pedestrian—even though technically proficient in the limited sense. The idealized role of the universities is then to put the fine cutting edge on the massive and relatively blunt intellectual tools which we are using.

This can be done in two ways. First, we must rapidly assume the responsibility for converting the callow and more or less half-baked interest and enthusiasm of our youth to solid competence. This is not an easy matter. The effects of this effort, vital as it is, will not be immediate. We are overwhelmed with false prophets and spurious advice. The most "scintillating advice" comes from those who are most remote from the classroom and academic laboratory. By and large laymen do not attempt to tell a surgeon how to conduct an operation, or a navigator how to steer a ship, or a plumber how to caulk a joint. But everyone is an expert on education.

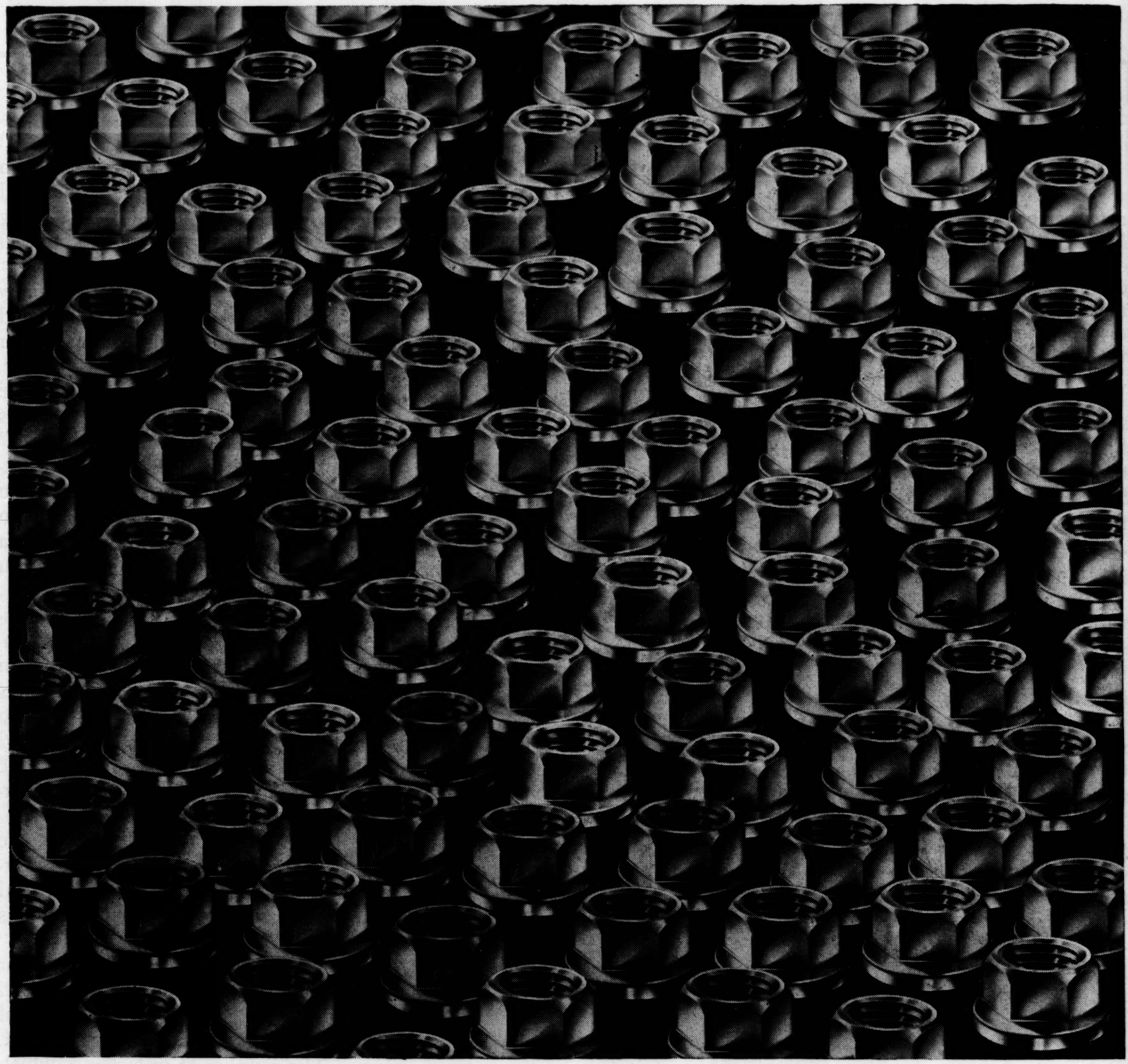
Those who have direct daily responsibility for classroom instruction are the first to admit that the education of young people is one of the most elusive of human enterprises. Yet, by and large, colleges and universities have brought our culture to where it is today, and no other segment of our culture, as yet, has demonstrated a comparable level of capability in transforming the interest and enthusiasm of youth into broad-gage leadership.

We believe that we can continue to do so in the space science field though we do not promise overnight miracles. And we will need substantial federal assistance if we are to match the national ambitions in this new field of human endeavor.

Secondly, I believe that the graduate colleges of our universities have the potential for contributing in an essential, direct, and foresighted way to fundamental advances in space science and, perhaps to a lesser extent, in space technology. The number of universities which have thus far done so may possibly be counted on the fingers of two hands and those which have actually been present "on the firing line" in an essential way are even fewer.

Yet as a matter of national policy, if for no other reason, this situation must and can be drastically improved. Only if universities are full-fledged partners in the national space effort can we develop the broad-gage, long-term competence which the public and the Congress so ardently expect. I commend this subject to the National Science Foundation, to the National Aeronautics and Space Administration, and to enlightened segments of the Department of Defense, such as the Office of Naval Research, for their sympathetic consideration.

We do not need gimmicks. But we do need facilities. We need research support, we need to establish a favorable competitive situation for the maintenance of a professional faculty and staff, and we need student fellowships. The cost is a minuscule fraction of the national space budget. I believe that the results will be strikingly important.



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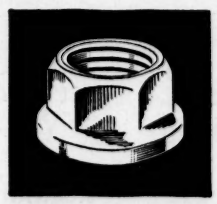

Perhaps nothing speaks so eloquently of an aircraft fastener's reliability as its acceptance by the men who actually use it. That's why we make a point of the FN 12's enormous popularity. Over 60,000,000 of these SPS featherweight locknuts—the first to meet MS 21042 and NAS 1291 standards—are now in use by the aerospace industry.

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WHO'S WHERE

In the Front Office

Frank L. Frain, vice president-treasurer, and **J. R. Janssen,** vice president-controller, Lockheed Aircraft Corp., Burbank, Calif. Also: **M. B. Stamey,** assistant treasurer.

Dr. Donald A. Hicks, vice president-engineering, Radioplane Division of Northrop Corp., Van Nuys, Calif.

James H. Douglas, Jr., former Secretary of the Air Force and Deputy Secretary of Defense, elected a director of Controls Company of America, Schiller Park, Ill.

Robert C. Mahoney, controller, The Mitre Corp., Bedford, Mass.

Calvin A. Gongwer, vice president-special projects, Global Marine Exploration Co., Los Angeles, Calif. Mr. Gongwer continues as manager of Aerojet-General's Oceanics Division. Aerojet has a 45% interest in Global Marine.

Robert I. Barry Jr., vice president, Defense Systems Services, Arcs Research & Development Corp., a subsidiary of Arcs Industries, Inc., New York, N. Y.

George R. Spitzer, assistant to the president, Missile Systems Corp., Beverly Hills.

Honors and Elections

Maj. Robert M. White, USAF, and **Joseph A. Walker,** NASA, have been jointly awarded the Iven C. Kincheloe Award, presented for outstanding contribution to flight testing as a pilot, for their X-15 flights during the previous year.

The Federation Aeronautique Internationale has presented the FAI de la Vaulx Medal, awarded to pilots who break absolute world records, to **Cmdr. J. P. Davis,** USN, and **Lt. Col. Thomas R. Grissom,** USAF; Paul Tissandier Diplomas, awarded to persons who have served the cause of aviation —particularly private and sporting aviation, were presented to aviatrix **Arlene Davis; Martin M. Decker,** president of the Decker Corp.; pilot **Max Conrad.**

Changes

Lyle S. Garlock, former Assistant Secretary of the USAF, appointed director of federal activities for Eastern Air Lines in Washington, D. C., succeeding **Robert Ramspeck,** retiring

Dr. Morton B. Prince, manager-microelectronics, Solid State Division, Electro-Optical Systems, Inc., Los Angeles, Calif.

General Electric Co.'s Heavy Military Electronics Department, Syracuse, N. Y., has established three new engineering subsections and appointed the following managers: **Kenneth D. Greenhalgh** for Undersea Acoustics Systems Engineering; **L. H. Lynn** for Ordnance Radar Systems Engineering; **Earl A. Stebbins** for Marine and Ground Radar Systems Engineering.

Air Vice Marshal G. P. Chamberlain, managing director, Collins Radio Co. of England, Ltd.

Malcolm F. McConnell, director of the newly established Facilities Engineering Division, Marquardt Corp., Van Nuys, Calif.

Paul J. Meeks, associate director, Special Systems Organization, Space-General Corp., Glendale, Calif.

INDUSTRY OBSERVER

► Knowledgeable U. S. scientific estimates of Russia's capability in development of electric propulsion systems place the Soviets approximately a year and a half ahead of the U. S.

► **First orbital shots of Dyna-Soar boost glider will probably employ a modified Titan II booster with segmented solids positioned around the booster (AW Sept. 25 p. 207) as chances of using a Saturn or other large booster now appear nil in view of Defense Secretary McNamara's coolness toward the Dyna-Soar program (AW Oct. 9 p. 21).**

► Air Force may soon decide whether to proceed with the selection of a contractor to conduct more precise studies of a manned, maneuverable global space surveillance system after evaluation of four system studies (SR 178) by Aeronautical Systems Division (AW Sept. 18 p. 28). Boeing and North American rated highly in the ASD evaluation. Boeing has proposed a vehicle based on the Dyna-Soar configuration while North American has a different vehicle concept, capable of supporting a man in orbit for several weeks. Human observers in surveillance spacecraft are likely to be the most controversial features of any system evolving from SR 178.

► **NASA is showing considerable interest in unsolicited proposals from Rocketdyne, Aerojet and Pratt & Whitney for 1- to 1.5-million lb. thrust hydrogen fuel rocket engines for use in upper stages of the Nova vehicle. NASA refers to the concept as the Y-1 engine, and the Large Launch Vehicle Group now studying boosters reportedly has urged its development. Engine could be used in first stages, but would produce only 850,000 to 865,000 lb. of thrust at sea level, and with a lower specific impulse.**

► Decision to use a lightweight Mariner R for a Venus fly-by next August means the payload will miss the planet by 20,000 to 25,000 mi. instead of the 16,750 mi. planned for the original payload. Mariner R also will have to drop the ultraviolet spectrometer, which was to have been one of the two main experiments, but will carry temperature sensors. Switch to a lighter payload and the Atlas-Agena booster is being made because the Centaur vehicle will not be ready for the heavier package (AW Oct. 2, p. 21).

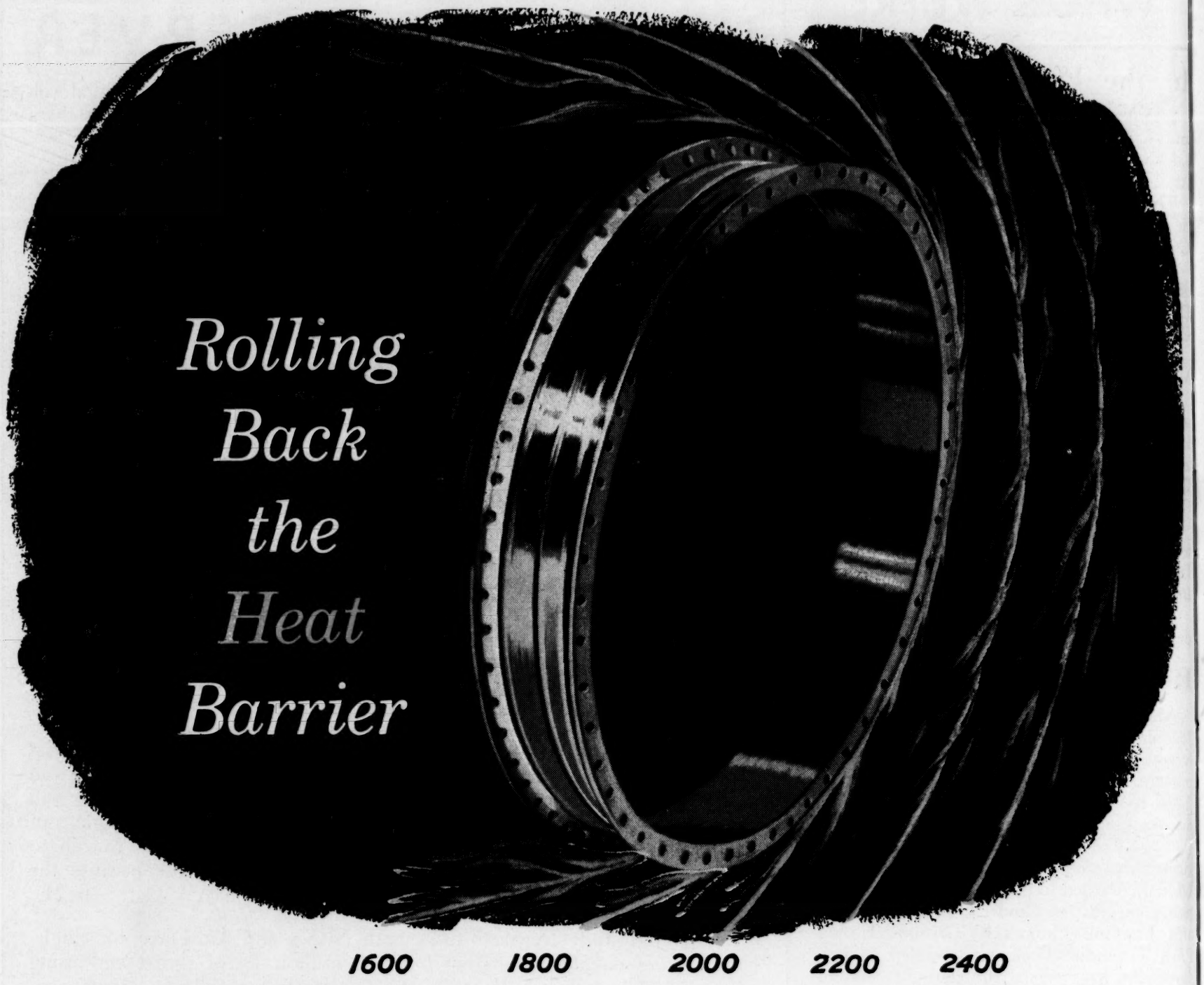
► **Aerojet has study contracts from both NASA and Air Force for single-barrel rocket engines generating 6 to 10 million lb. of thrust and using either liquid hydrogen fuel or storable hypergolic propellants. Each contract is for less than $1 million; one includes some hardware development.**

► Studies by Convair, Hughes and Space Technology Laboratories on the ballistic missile boost intercept (Bambi) concept of defense against ICBMs indicate enough technical feasibility that the contractors have recommended building experimental hardware for tests against U. S. missiles at a cost of about $40 million. Economic feasibility still is open to question due to the cost of keeping a thousand or more satellites in orbit and because of their potential vulnerability to satellite interceptors.

► **Aerojet has proposed a Hylas-Star rocket stage that would generate 20,000 lb. thrust and have a burning time of 200-300 sec. It would use a helium-pressurized liquid hydrogen fuel system and be based on the Able-Star stage now in use. Engine would use an ablative nozzle and could send more than 12,000 lb. into an escape trajectory. Stage has been proposed for use on the Titan II, and might also be used as a backup or follow-on to the Pratt & Whitney Centaur liquid hydrogen stage.**

► Earth current communications techniques, planned for Minuteman missile launch control and for Strategic Air Command Control System, may also be able to provide shore-to-ship and ship-to-ship underwater communications. Another possibility is for use in locating ships and submarines that are completely silent and protected against sonar detection. It has been determined that earth current techniques can be used to locate large masses, but relative sensitivity has not been established.

► **Jet Propulsion Laboratory is considering installing a television camera on a high derrick on the Surveyor soft lunar landing vehicle in order to view the largest possible area of the moon's surface.**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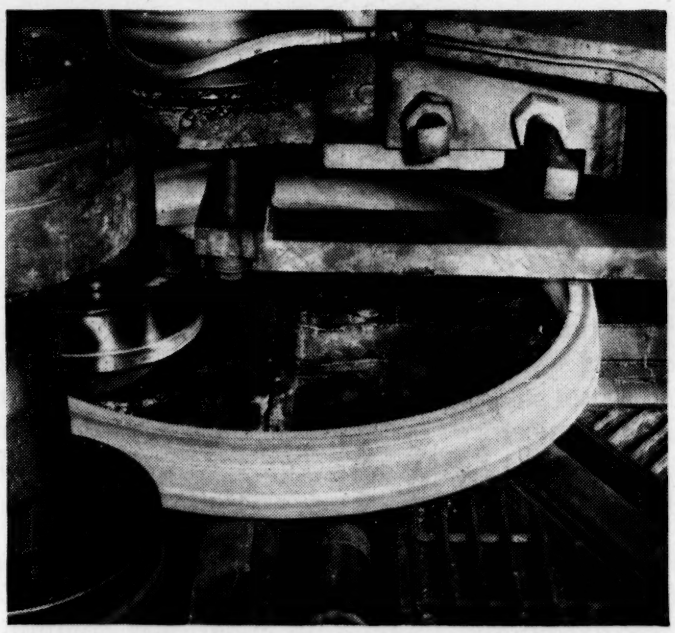

Manufacturer uses ring-roller to shape turbine seal rings made of HASTELLOY alloy X

The surging power of modern 20,000-pound thrust jet engines is being harnessed effectively by critical parts made of HAYNES high-temperature alloys. Turbine seal areas are typical of the hot spots in which these alloys serve. Here, in the form of turbine seal rings, they contain the hot combustion gases as they roar through the various turbine stages.

In these, and in other parts too, such as afterburner liners, flame holders, shrouds, and investment-cast turbine blades and nozzle vanes, HAYNES alloys are resisting the punishing effects of long hours at high temperature. In fact, one of the Air Force's latest 1500-MPH jets uses six different HAYNES alloys in vital parts where heat and stress would weaken and fatigue other materials.

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Washington Roundup

New Budget Emphasis

Budget deliberations inside the National Aeronautics and Space Administration, Pentagon and White House are going beyond specific spending requests and focusing increasingly on their impact on the over-all U. S. economy.

This emphasis is part of the Kennedy Administration's attempt to harness space and military spending to its economic recovery effort. President Kennedy's Council of Economic Advisers is heading a new study of the impact of this type of spending. One spokesman told AVIATION WEEK the council is also trying to get "a detailed snapshot" of the national economy in the late 1960s so it can determine how much space and military spending the U. S. can afford.

Some military leaders are complaining that this new economic atmosphere is handicapping their weapons experts and giving the edge to budgeteers in current Pentagon spending debates. NASA leaders, in contrast, are capitalizing on the Administration's economic interest by pointing out how space spending is uplifting depressed areas of the U. S.

IAF Congress Site

Next year's International Astronautical Congress will be in Sofia, Bulgaria—the first ever to be held in an Iron Curtain country. It is scheduled for mid-October. The 1963 congress will be in Buenos Aires, Argentina. Mexico, Yugoslavia, West Germany and Poland also offered to serve as hosts for the 1963 meeting.

Debate over who should own and operate the communications satellite system continues without letup throughout the congressional recess. Chairman Russell B. Long of the Senate monopoly subcommittee will resume his hearings on the subject Nov. 8 and plans to call in all Federal Communications Commission members as well as industry leaders interested in developing the system.

Backdrop for the hearings will be communication industry's own recommendations to FCC on system ownership. Revival of congressional activity is accompanied by debates among private groups about communications satellites. The issue, for example, has split Americans for Democratic Action, which wants public ownership, and the Communication Workers (AFL-CIO), whose president said only private development will assure the U. S. is first with the system.

Soviet delegates to the International Astronautical Congress displayed interest in the Naval Research Laboratory's work with very low frequency radio propagation conducted with the Lofti I satellite. Vladimir A. Kotelnikov, Soviet academician, said no similar experiments have been conducted with Russian satellites. But he said he hoped to do so to determine if VLF signals can communicate with satellites half-way around the world.

SAGE Dispute

Argument between the Air Force and Federal Aviation Agency over the future use of SAGE intercept computers is delaying the release of the long-overdue Project Beacon report on air traffic control. Air Force need for the expensive computer system is diminishing. Several Air Force leaders are pressing FAA to use the system for air traffic control. But the Project Beacon report recommends against this. FAA Administrator N. E. Halaby, who so far has been unable to soften Air Force opposition to this recommendation, now hints he may release Project Beacon as it stands.

National Aeronautics and Space Administration is trying to keep private industry informed of its technical findings as the space program progresses. John Burke, vice president of the Siegler Corp. of Los Angeles, has started a four-month assignment with the agency to help do this.

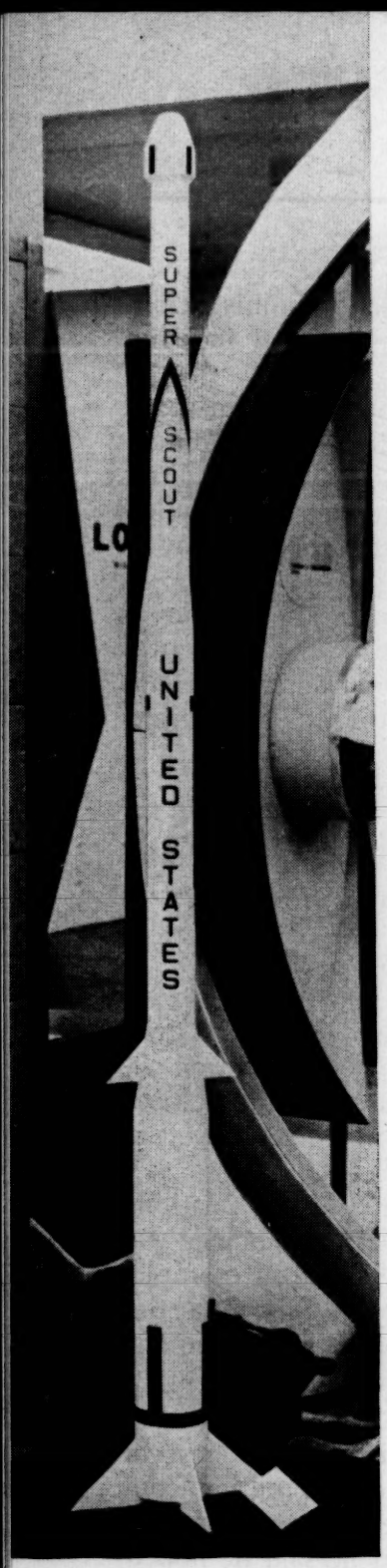
Mayor's Choice

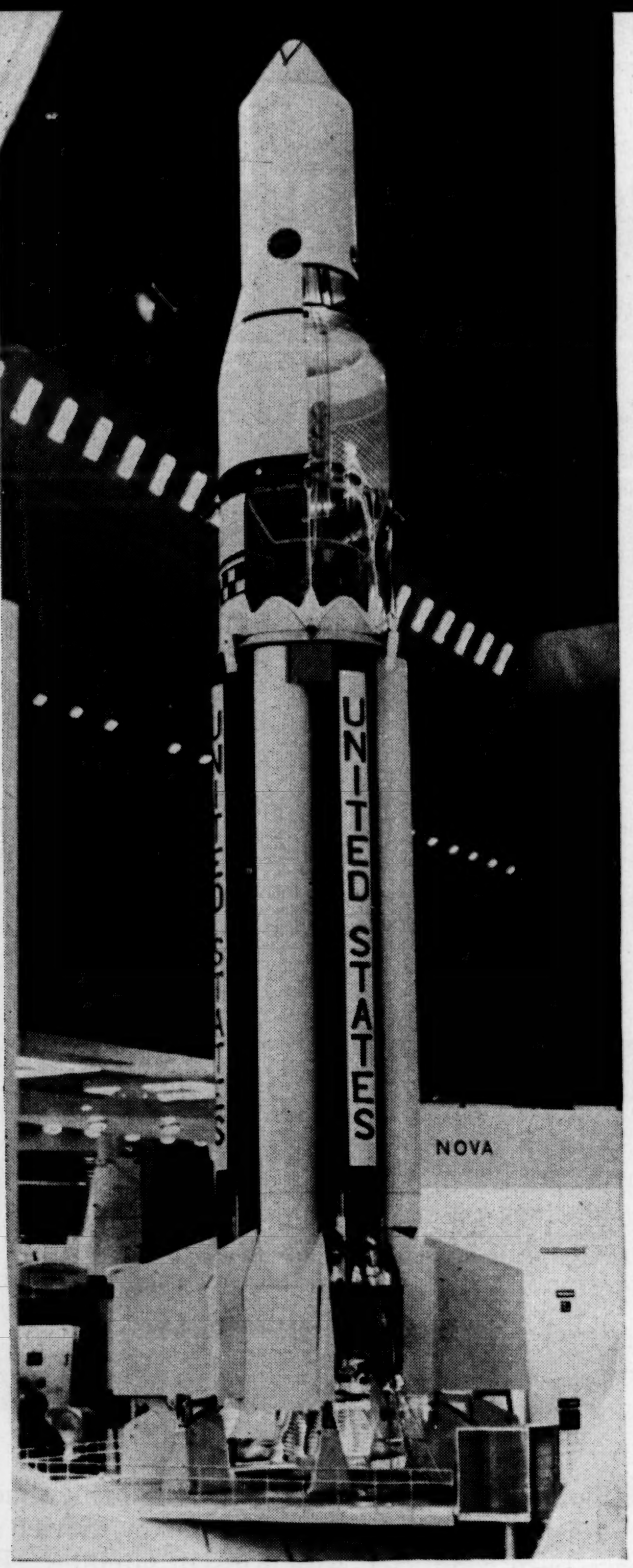
Mayor Robert F. Wagner of New York passed up his scheduled welcoming address to the American Rocket Society's Space Flight Report to the Nation (see p. 27) so he could open the U. S. toy manufacturers' First Spring and Summer Toy Market Week. The mayor told the toy makers of his "personal admiration for the ingenuity and creativeness of the American toy industry through the years."

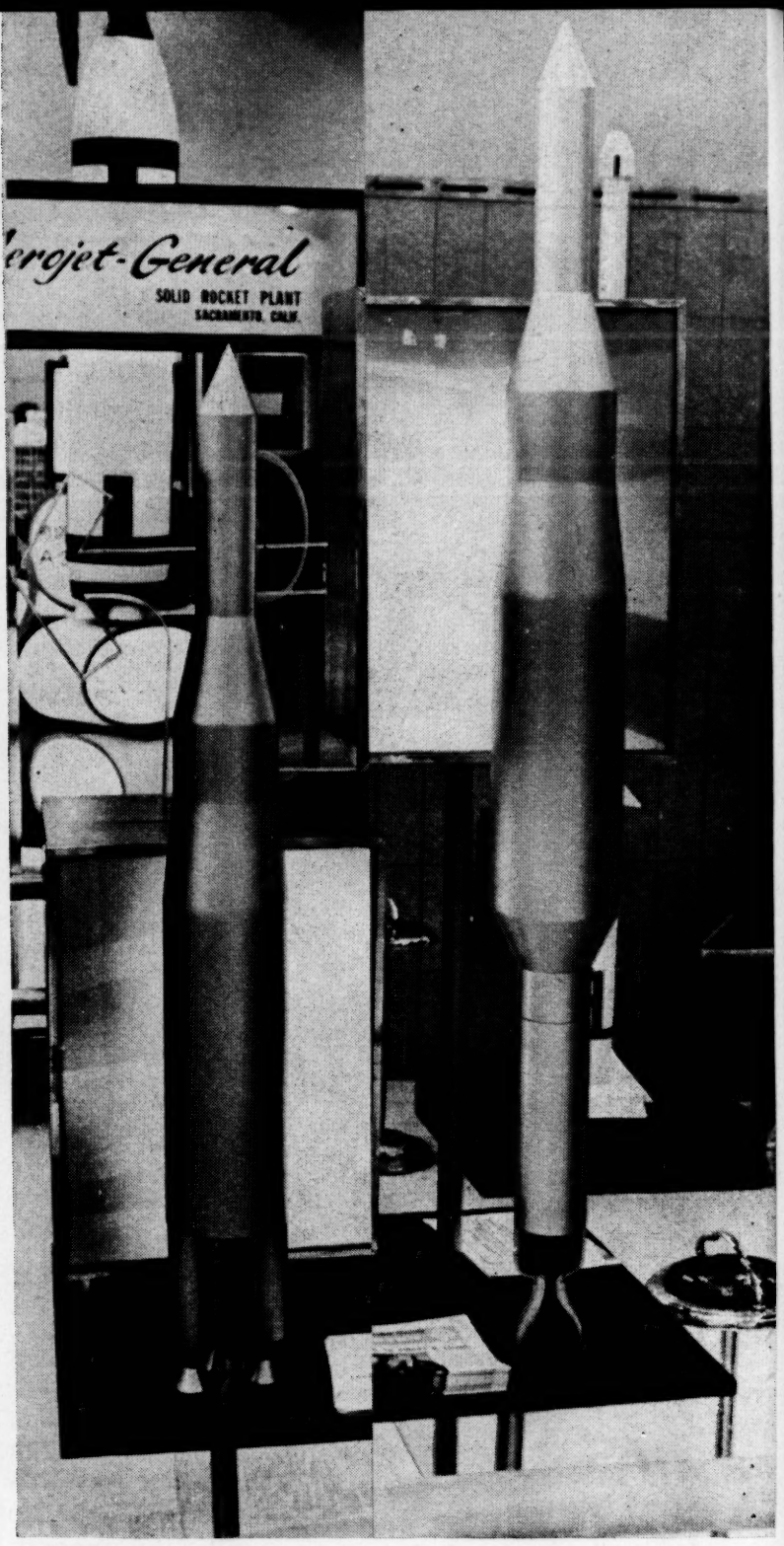
Chief of Naval Operations recently received this wire from the Naval Medical School at Pensacola, Fla.: "Request authority for civilian Miss Jerrie Cobb to fly in Naval aircraft for purpose of baseline studies designed to determine fundamental differences between male and female astronauts. . . ."

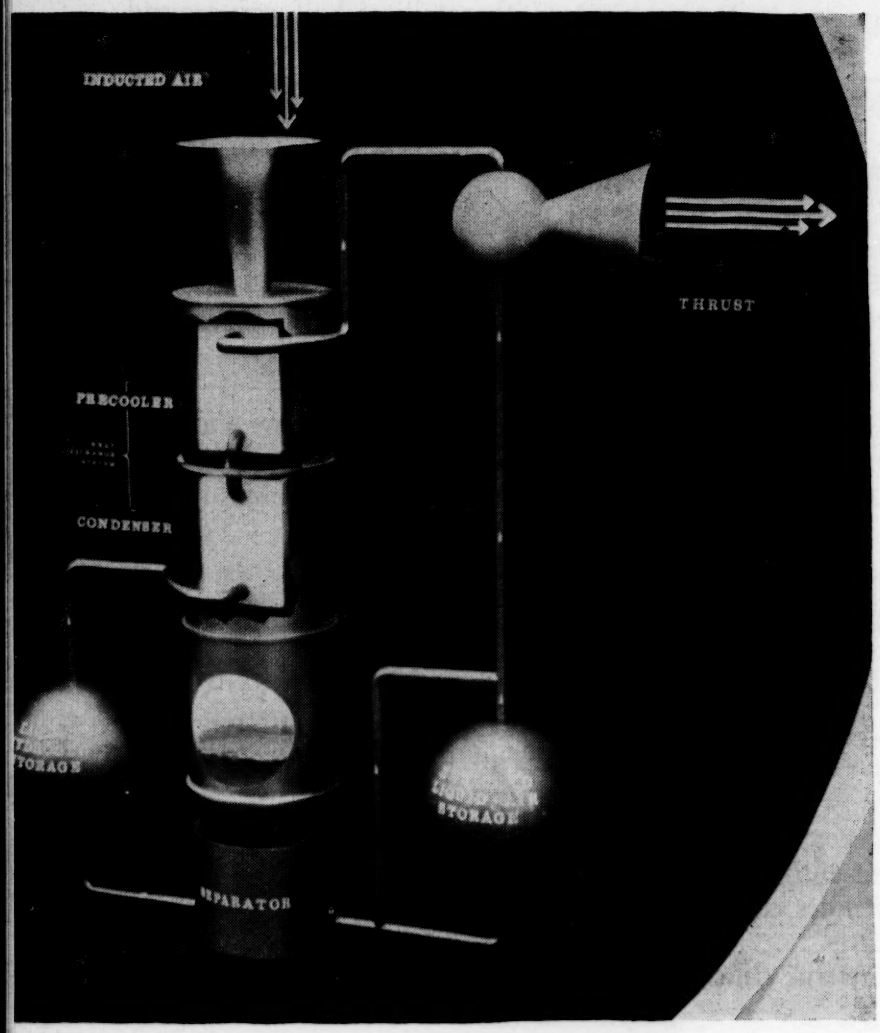
The reply: "If you don't know the difference already, we refuse to put any money into the project."

—Washington Staff



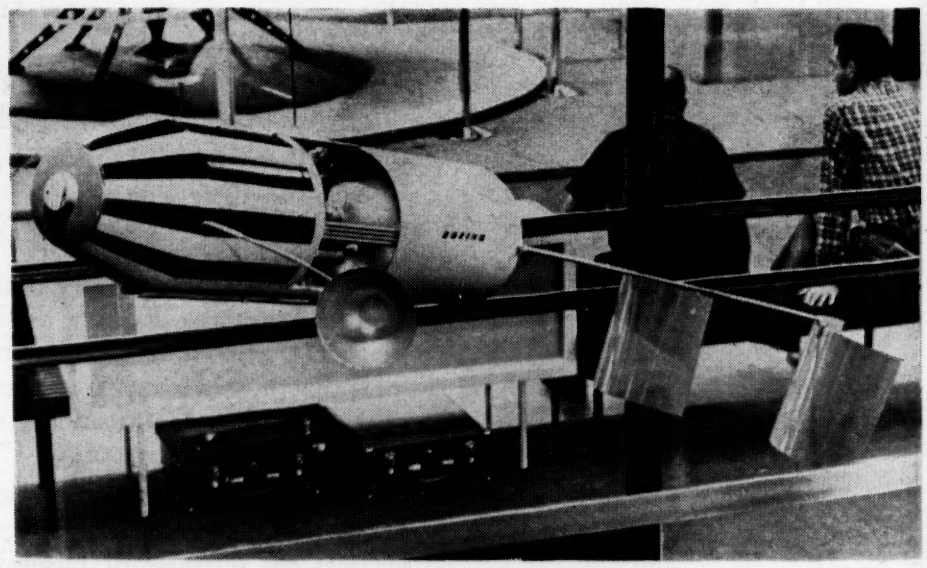






Finned Saturn, Boosters at ARS

Aerojet proposal for upgraded propulsion system for Super Scout (above, left) would give payload capability of 1,000 lb. in 300-naut.-mi. orbit. Finned Saturn model (above, center) shows addition of eight aerodynamic surfaces for increased static stability. Aerojet conceptual models (right) show contrast in size of weight-limited designs using clustered rockets (model at left) and cylindrically segmented, cast-in-case propellant type. Saturn design, left, would be 190 ft. high; one at right, 230 ft. high.



Boeing model (above) shows 12-man permanent space station for 300-naut.-mi. orbit. Marquardt Corp. liquid-air cycle engine is shown diagramatically at left.

ARS Underscores U.S. Space Goals, Gaps

New York exhibit indicates nation's ambitions, but timetable for major achievements hinges on boosters.

New York—Mockups and models dominated the American Rocket Society Space Flight Report to the Nation last week, demonstrating not only the nation's glowing and growing ambitions in space but also the distance it must travel to turn concepts into hardware to fulfill these ambitions.

This gap was underscored by Dr. James A. Van Allen, discoverer of the earth's radiation belts, who used his nominal topic of education for space science and technology and the role of universities in space research (see p. 21) as a basis for comment on broader aspects of the nation's space programs. There is, he said, a "great chasm" between the "immense and rapidly growing ambitions in the field of space exploration, both manned and unmanned," and the nation's competence to achieve these ambitions.

Though all Dr. Van Allen's opinions were not universally shared here, speeches, technical sessions and comments by leaders of the country's space effort all recognized the existence of a gap between proposal and performance. Four years after Sputnik I, for example, the primary limiting factor in the U. S. program still is powerplants, and the national booster program is sprinkled with uncertainties.

Such basic decisions as whether man will be placed on the moon by direct flight or through the use of orbital rendezvous, what type of vehicle will be used for the mission, and how large the Apollo spacecraft that will carry him can be, are still unresolved.

Key to these questions will be the report of the Large Launch Vehicles Group headed by Dr. Nicholas Golovin of National Aeronautics and Space Administration, which is due to report by Nov. 1. This is a joint Defense Department-NASA group, and final decisions on powerplants in all thrust classes have been withheld for 90 days.

Most of the basic decisions affecting the Apollo and its boosters for various missions are expected to be made by the end of this year.

Possibility that NASA will shift its Apollo manned lunar landing mission from direct ascent to rendezvous was apparent in remarks made by NASA Administrator James E. Webb and Wernher von Braun, director of the agency's Marshall Space Flight Center.

Von Braun said the flight techniques under active consideration for the Apollo lunar mission have narrowed to:

- **Payload assembly in orbit,** using four Saturn C-3 boosters, each of which would carry 100,000 lb. into an earth orbit.
- **Use of the Saturn C-4** on two assembly-in-orbit flights. The C-4, using a cluster of four Rocketdyne F-1 engines, doubles the C-3 payload. Saturn C-3 is a cluster of two F-1 engines.
- **Direct ascent,** with a Nova vehicle based on a booster cluster of eight F-1 engines. Nova could carry the 160,000-lb. Apollo payload in one direct flight.

The Apollo spacecraft configuration cannot be frozen until a decision is made on the course NASA will follow in the mission trajectory, but Webb said the F-1 engine is the pacing item; the spacecraft is not.

NASA last week received Apollo spacecraft proposals from five contracting teams, headed by General Dynamics, General Electric, Martin, McDonnell and North American (AW Sept. 4, p. 23). Each team made oral presentations and the written and oral material went to a NASA source selection board late last week. Webb said an Apollo vehicle contract will be awarded before the end of the year.

Von Braun said the basic flight trajectory decision will mean NASA will build either the C-3 or C-4 Saturn vehicle, but not both. Webb, who has not missed an opportunity since mid-September to emphasize NASA studies on rendezvous (AW Sept. 18, p. 26) said assembly in orbit potentially is the fastest, best, cheapest and most reliable flight technique for manned lunar landing. The problem, according to von Braun, is that all aspects of rendezvous are not understood.

NASA plans to evaluate rendezvous with at least one mission during Fiscal 1962, with two programs being considered. One involves an attempt to join an Agena chaser vehicle with a Project Mercury capsule, and the other is to use a Scout-launched homer to join with a Mercury capsule target. The agency will spend $8 million on rendezvous development during the fiscal year.

Webb estimated that rendezvous could cut a year and possibly two years from the manned lunar landing timetable over a direct ascent, because the smaller F-1 booster clusters will be available before the eight-engine Nova.

Complicating the NASA decision is the solid propellant Nova program. The solid Nova is being developed under Air Force Systems Command management to NASA's specifications as a parallel program with the liquid-fueled Nova under development by NASA.

Air Force is studying a family of smaller solid propellant launch vehicles, called Standard Launch Vehicles (SLV), and the rendezvous technique instead of the mammoth, multi-clustered stages of the 20 million lb. thrust Nova. Using clustered 120-in.-dia. in the first stage, but single 120-in. engines in the upper stages, USAF is advancing the argument that this system would provide an operational launch capability in shorter time, increase launch vehicle reliability and simplify guidance and control problem.

Air Force also is investigating the upper stress limits that man can safely undergo in space. Ling-Temco-Vought described an experimental restraint system being developed under Aeronautical Systems Division sponsorship that would protect a man against an impact load of 60g. Some bioastronautics observers indicated that USAF is interested in knowing man's survivability under very high g loads, since this is considered one of the pacing factors of manned spacecraft re-entry. USAF's philosophy apparently is this: The higher the g loads that the pilot can take, the wider the re-entry corridor; the wider the corridor, the less sophisticated the guidance and control and midcourse correction propulsion systems. The simpler these systems are, the lighter their weight; the lesser weight and complexity, in turn, will simplify the rendezvous operation and the logistics involved in assembling the launch vehicle and spacecraft and sharply reduce the time necessary to develop the complete manned system.

NASA takes the opposite tack. Apollo specifications, for example, call for a crew to experience less than 12g on its re-entry to earth after a lunar landing or circumlunar mission. This factor, combined with a lift-drag ratio of 0.5, will necessitate a corridor between 10 and 30 mi. wide—a small target that will require a very precise guidance and control system and a midcourse correction system capable of 10-min. burning time. NASA's approach is more cautious and has a lower risk factor, but involves greater systems complexity and longer lead times.

Controversy between the proponents of liquid and solid propellant systems still continues, with both sides able to show continuing advances in their technologies.

By now, both sides have learned

that neither system is the one answer to all problems. Current examination of propulsion systems for space flight is being conducted on the sole basis of the mission to be flown. These studies, at this stage of engine development, clearly underline the superiority of the liquid-propellant high-energy system as the best selection for upper stages of space vehicles.

But selection is not so simply determined for other stages of space vehicles. Currently the choice is heavily weighted on the side of the liquid-propellant system, primarily because it has accumulated a larger backlog of experience and technical history than the large solid type. Rocketdyne's F-1 engine, rated at 1.5 million lb. thrust, is a going program, with a sizable amount of running time on thrust chamber and ancillary systems behind it. The company's J-2 upper-stage engine, operating on liquid hydrogen and liquid oxygen and developing 200,000 lb. thrust, is well advanced in development.

Solid Rocket Technology

Solid rocket technology, in contrast, still has to produce the huge diameter, long-burning-time grains needed for space missions. Segmented rockets appear now to offer the most promising solutions, but so far the largest unit fired—Aerojet-General's 100-in. engine—has developed 500,000 lb. of thrust, a far cry from the multi-million-pound ratings necessary for space missions.

The problem is complicated by a number of factors which reflect accurately the real difficulties of the mission profiles, and the complexity of the over-all system required.

Development time and cost are important, but not overriding considerations in the final choice of propulsion systems. Other major elements are stage build-up, vehicle compatibility, structure and guidance considerations, and implications of the launch process itself.

The evidence now available, said NASA's Elliot Mitchell, does not demonstrate the superiority of either approach.

There is further argument within the ranks of the solid-propellant proponents, who are split generally into two camps: those who believe huge motors can best be made in one piece, and those who feel only the segmented approach is feasible. William Cohen, also of NASA, pointed out that there is no propellant plant in existence that can make a motor containing a million pounds of propellant, and measuring 15 ft. in diameter by 70 ft. long.

New techniques of on-site mixing and pouring, setting the enormous engine upright in a floodable basin for casting, and shrouding it for water transportation to the launching site, have been suggested as possible solutions.

Segmented engines, cast in pieces and transported to the launch site for assembly and firing, represent the general approach taken by the opponents of the one-piece engine. They say the development of reliable joints between adjacent segments means over-all levels of reliability can be reached which are not inferior to those of the typical one-piece motor.

But whether the solid-propellant system is built in one chunk or from many, there is still one very difficult problem remaining: man-rating the engine. Abort of a mission may be necessary, and elaborate systems have been devised to make escape possible from current and visualized liquid-propellant rocket systems. These systems use a variety of sensors which monitor the many pressures, flow rates or pump velocities, and which can quickly detect something going wrong. There are comparable parameters to watch on a solid-propellant rocket—chamber pressure, case burn-through or overheating—but no current system exists for an abort system based on those factors.

Assuming a lunar soft-landing mission and return, T. E. Myers and S. C. Britton of North American Aviation's Rocketdyne Division studied the solid-propellant system requirements and concluded they could provide a better way to do the job than liquid-propellant powerplants.

Today's better solids, they say, can show mass fractions of about 0.91 using lightweight metal cases, and up to 0.95 with plastic bonded fiber glass housings. But if these have to be segmented units, then the fraction must drop to about 0.89 and 0.93.

Current solid propellants deliver specific impulses between 240 and 290 sec. depending on the chemical combination chosen and the operational altitude. The authors say that using nitronium perchlorate, a new oxidizer, the minimum figure may be raised as high as 265 sec. But the easiest way to increase the specific impulse is to load the propellant with beryllium, substituting it for the aluminum commonly used now. This substitution raises specific impulses by 15 to 20 sec. It also raises the problem of toxicity, both in fabrication and at the firing site. Even with this hazard, Myers and Britton believe beryllium will be useful in upper-stage vehicles or lunar-return launch vehicles.

The consumable-case concept, in which the outer portion of the propellant grain is made strong enough to take some of the chamber pressure load, offers another alternative for increased performance. The Rocketdyne authors said one approach under development by their company promised to give mass fractions as high as 0.97, equivalent to raising the delivered specific impulse by 25 to 35 sec.

But they warn the production capacity of various chemicals must be increased considerably if supply needs are to be met. For a space program requiring one launching a month of vehicles using typical composite propellants, the annual usage of ammonium perchlorate would be 46,000 tons. This is con-

Glass Fiber Minuteman Proposed

New York—Air Force is considering an advanced version of the Minuteman solid propellant missile which would consist of an all glass fiber airframe, propellants of higher specific impulse and a second generation inertial guidance system.

USAF has recently awarded Thiokol Chemical Corp., manufacturer of the first stage, a contract for motors using glass fiber cases identical in size and shape to the steel cases now being built by several companies under subcontract to Thiokol. H. I. Thompson Fiber Glass Co., Los Angeles, Calif., will develop the new cases.

Hercules Powder Co., manufacturer of the third stage, already uses a glass fiber case. Aerojet-General, which has been fabricating second stage cases from titanium and steel, has made and tested a number of glass fiber units.

Space Technology Laboratories, which is still performing systems management and technical direction of ballistic missile weapon systems for the Air Force, is understood to be skeptical of this new concept because of the buckling problem that might be encountered with the glass fiber shells. USAF, however, is interested enough in the greater range and heavier warhead possibilities offered by the advanced Minuteman that it has ordered tests to prove out the concept.

Industry sources indicate that an all glass fiber airframe might increase the missile's mass fraction by about 3%.

All three companies are working on new propellants. Initially, Aerojet, Hercules and Thiokol will improve the specific impulse of the propellants now used in Minuteman in small arithmetic progressions, but all three are working on completely new fuels. One source indicated that liquid and gas secondary injection is also being considered for thrust vector control, with the latter technique—bled from the combustion chamber—being favored at present.

Autonetics Division of North American Aviation is now developing a lighter weight inertial guidance system, with a greater memory storage capacity.

siderably more than the current production of the chemical, and most of that current production goes to other uses.

Finally, Myers and Britton suggest on-site loading, using new processing techniques which would reduce mixing time, temperature and friction. Techniques based on slurries, carriers, or solvent concepts look promising.

Importance of developing a spacecraft rendezvous capability was emphasized again by Edwin G. Johnsen of NASA, who said the large nuclear-powered spacecraft needed for planetary missions will have to be assembled in orbit. Johnsen said he personally believes that "within the foreseeable future, we will be planning a U. S. Orbit Test Facility."

A nuclear vehicle for planetary flights would weigh an estimated 900,000 to 1 million lb., Johnsen said, and would have three stages propelled by engines having nuclear-thermal powers in the 1,000 to 8,000 megawatt range. These engines should be pre-flight tested, probably with a full power run of the engine, before leaving orbit on a planetary trajectory, Johnsen said.

This, he believes, will require an orbital test facility including a liquid hydrogen storage and transfer system; rocket propellant to keep the facility in its proper altitude and orbit path; auxiliary power, probably supplied by a small nuclear generator, and a life support system where personnel can eat and sleep in the several days that assembly and test will require.

Earth-based radio midcourse guidance will be sufficiently accurate for the majority of unmanned missions to the moon and nearer planets, but a vehicle-borne celestial navigator does appear necessary for missions to more distant planets such as Jupiter and Saturn, J. R. Scull of Jet Propulsion Laboratory told the ARS.

For interplanetary missions, an approach guidance system which goes into operation at a distance of one or two million miles from the planet, using angular measurements to celestial bodies relative to the target planet, can reduce guidance error from a few thousand miles to a few tens or hundreds of miles, Scull predicted.

NASA's funding of electric propulsion developments is expected to total $9.7 million in Fiscal 1962, compared with $3.3 million in Fiscal 1961 and $1.1 million the previous year, USAF Capt. Richard J. Hayes, assigned to NASA, told the conference. Hayes estimated that electric propulsion funding would increase dramatically, reaching perhaps $50 million by 1965.

Dr. A. T. Forrester of Electro-Optical Systems, Inc., which is developing cesium ion engines for both NASA and Air Force, said that his company has made "considerable advances" in performance since it announced the operation of an ion engine nine months ago which produced three millipounds of thrust with 65% over-all efficiency.

NASA plans to test ion engines built by Hughes, its own Lewis Research Center and by Electro-Optical Systems during 1962 in capsules launched into ballistic trajectories of about one-hour duration by Scout boosters.

Rapid progress in the field of electric propulsion has focused attention on the lack of suitable long-life, moderate-level electric power supplies for powering such engines on long space probes.

The Snap-8 nuclear turbo-electric space power system, capable of generating 30 kw., suitable for powering an electric propulsion unit on a useful space probe, is not scheduled for its first feasibility flight until 1965.

A nuclear thermo-electric system with lower power capability might be available sooner. However, new thermoelectric materials capable of long-life operation at higher temperatures in the 1,100F to 1,500F range are sorely needed, G. M. Anderson of the Atomic Energy Commission said.

Even the long-used low-power silicon solar cells are not without problems when used on satellites operating in the Van Allen radiation belts. Solar cells of the PNP type on a Discoverer satellite orbited at 1,850 mi. (in the most intense part of the Van Allen inner belt) experienced a 31% drop in voltage after 60 days exposure when protected with a 6-mil-thick cover glass, and a 14% drop when protected by a 60-mil-thick glass, Lockheed's Charles Burrell reported. Solar cells of the NPN type experienced only a 7% drop when protected with a 60-mil glass, Burrell said.

Very encouraging progress in the development of gallium arsenide solar cells, expected to be far more radiation resistant, was reported by Dr. Paul Rappaport of Radio Corp. of America. Tests to date indicate that gallium arsenide solar cells should be 10 times more resistant to protons and 2 to 10 times more resistant to electrons than silicon cells. Rappaport said that RCA has recently achieved conversion efficiencies with gallium arsenide that approach those of silicon. Rappaport quoted no figures but this statement should place the gallium arsenide conversion efficiency achieved by RCA at about 12%.

Much of the technical discussion on structures and materials was geared to lunar missions, and several different structural concepts were described as being under serious study for a lunar landing or an earth return mission.

Concepts showing the most promise are material deformation using a frangible tube to attenuate shock, collapsible shells, gas bags and retrorockets.

Speakers said material buckling has been found to be much more predictable than had been theorized, but like other methods of lunar landing, its success depends on a small horizontal velocity.

Saturn Launch Pad Changes

New York—Saturn Complex 39, being designed to handle the C-3 launch vehicle, will be a significant departure from other launch complexes at the Atlantic Missile Range in order to meet the rapid firing schedule planned for the vehicle, Dr. Kurt Debus, director of the National Aeronautics and Space Administration's AMR Launch Operations Directorate, told the American Rocket Society here.

The complex will combine assembly and checkout into a single shed area with a double bay. Assembly will be on a railroad flat car, about 20,000 ft. from a bare, concrete pad. Time lag from shed assembly to pad checkout will be eliminated, and launch can be made within a week from the time the vehicle reaches the pad.

Complex 34, the first Saturn complex, can accommodate only four vehicles a year, with two months of pad time and a month to rehabilitate the pad after launch, Debus said. With a series of two or three assembly-checkout sheds, the new complex can handle launch of 32 vehicles per year.

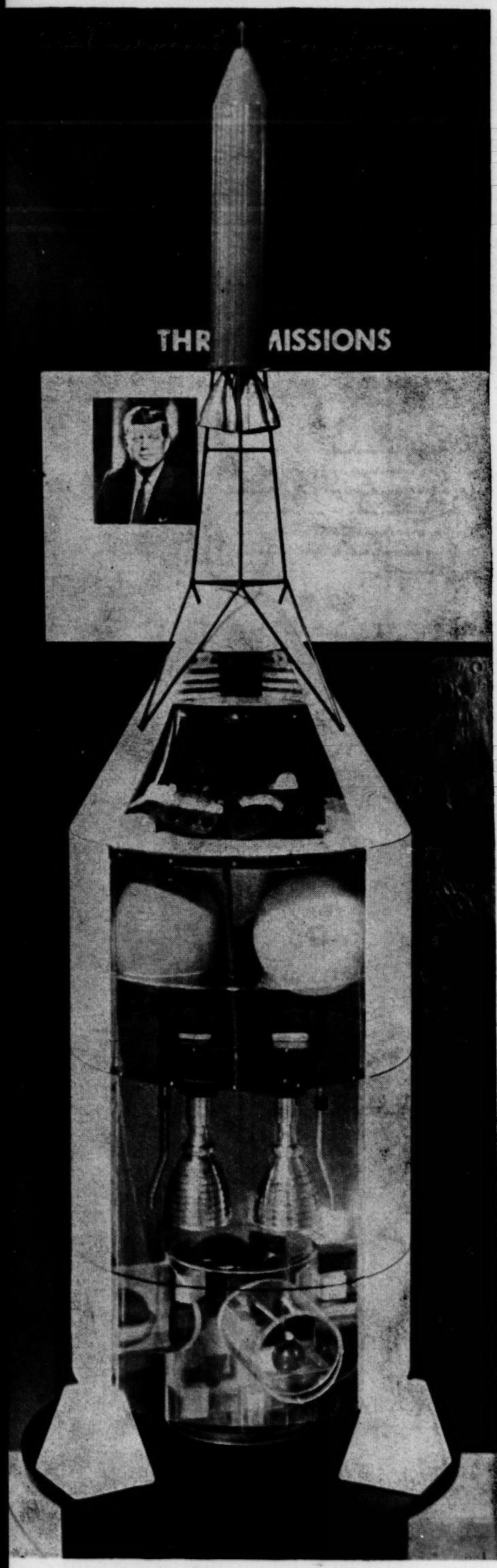
Complex 39 will cost an estimated $190 million, but if standard construction techniques were used, eight pads would be required and would cost about $360 million, Debus said.

Capability to launch large solid propellant vehicles can be added simply by constructing another assembly building, he said.

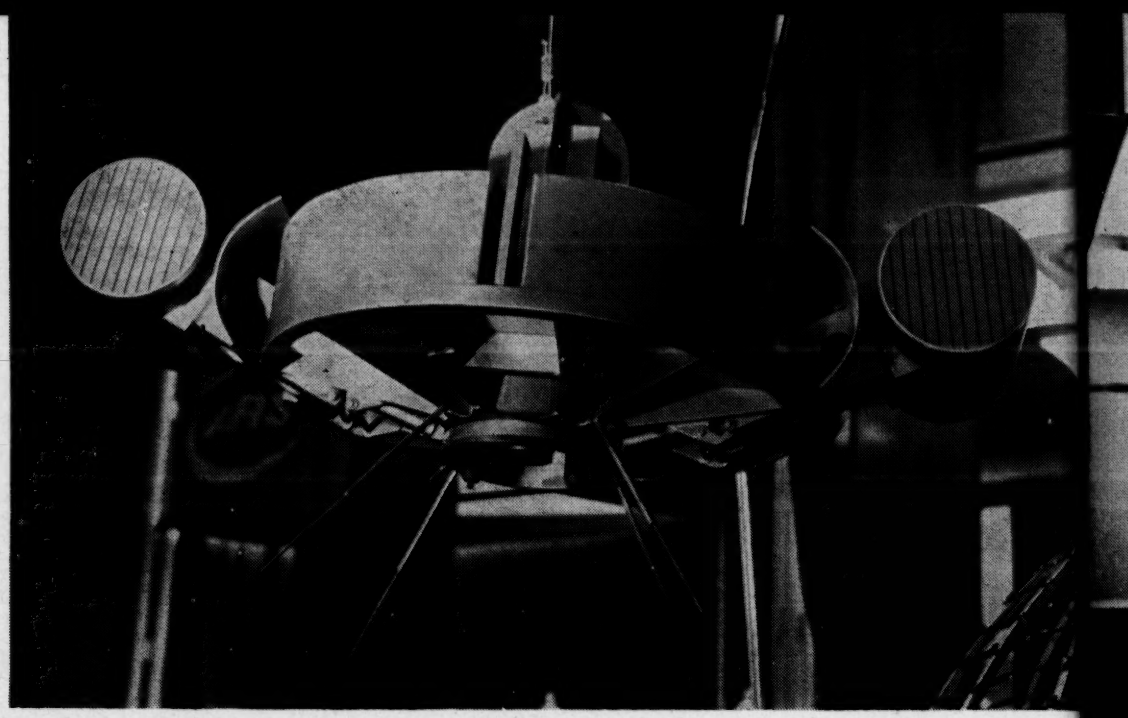
Under the present system, a service tower is required for access to the vehicle and to protect it from high winds. The tower is replaced at Complex 39 by catwalks around umbilical connector arms.

ARS Coverage

Coverage of the American Rocket Society's Space Flight Report to the Nation was handled by a team of Aviation Week editors composed of David A. Anderton, technical editor, Evert Clark, Washington bureau chief; Philip J. Klass, avionics editor, and Edward H. Kolcum and George Alexander, space technology.

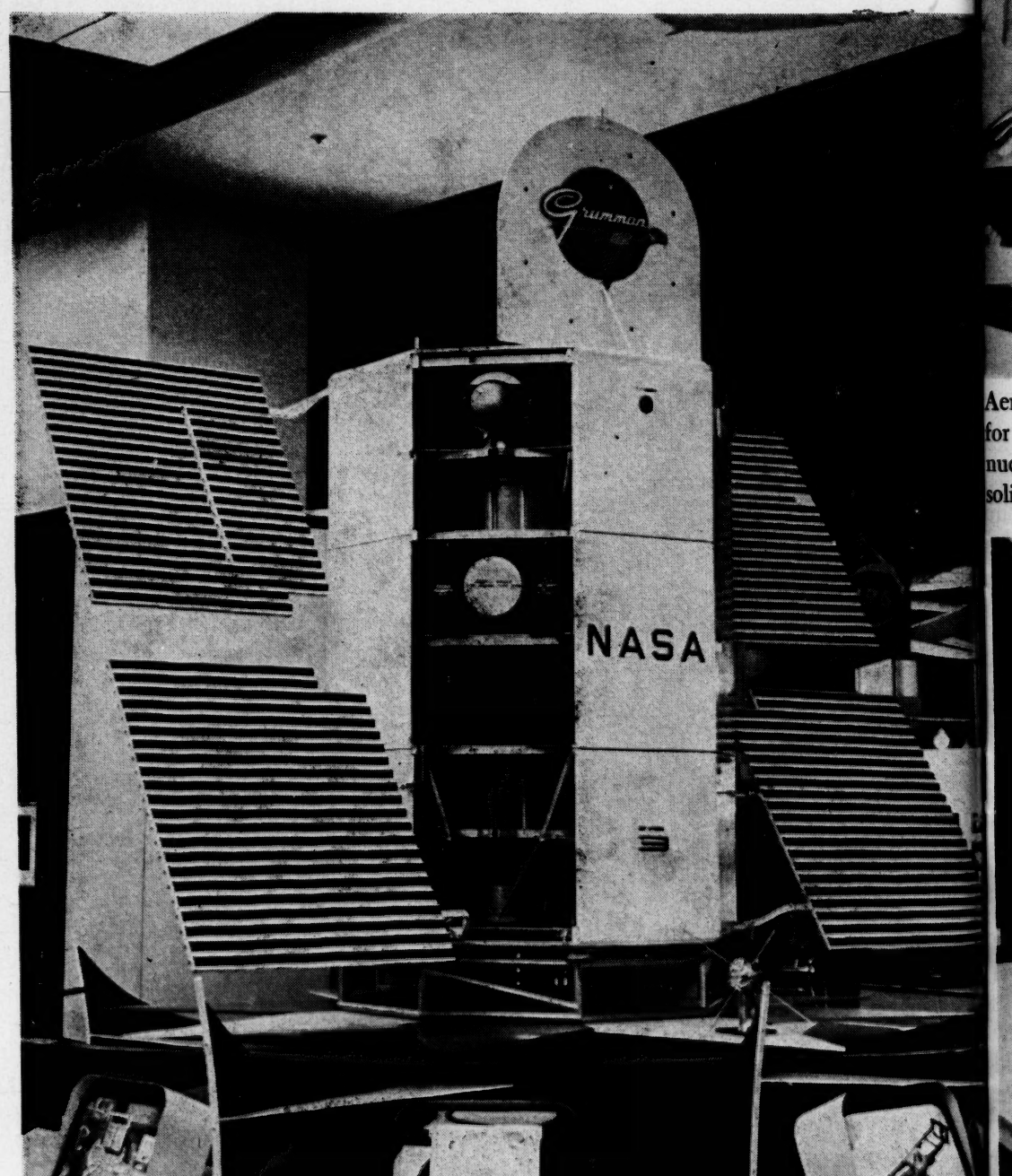


NASA Apollo concept houses three-man crew for circumlunar trip and ballistic re-entry. Escape tower at top and general layout of capsule shows strong influence of Mercury experience.

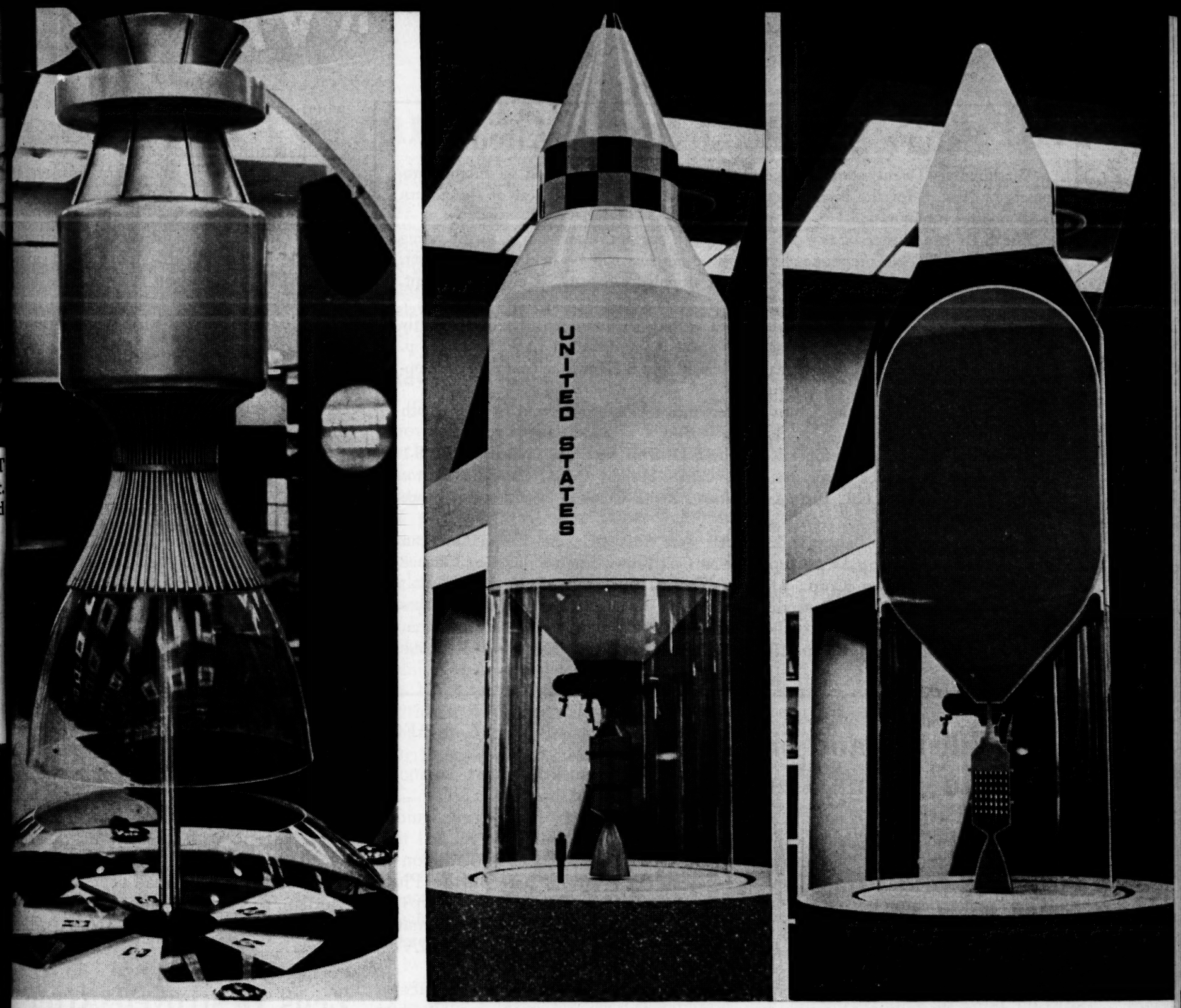


Ion engine flight-test package is modeled in this conceptual design of RCA's SERT (Space Electric Rocket Test) vehicle to be launched late next year by a Scout rocket. Electric engine packages, represented by grid-faced cylinders, will be used to spin and despin the 30-in.-dia. vehicle above altitudes of 100 mi.

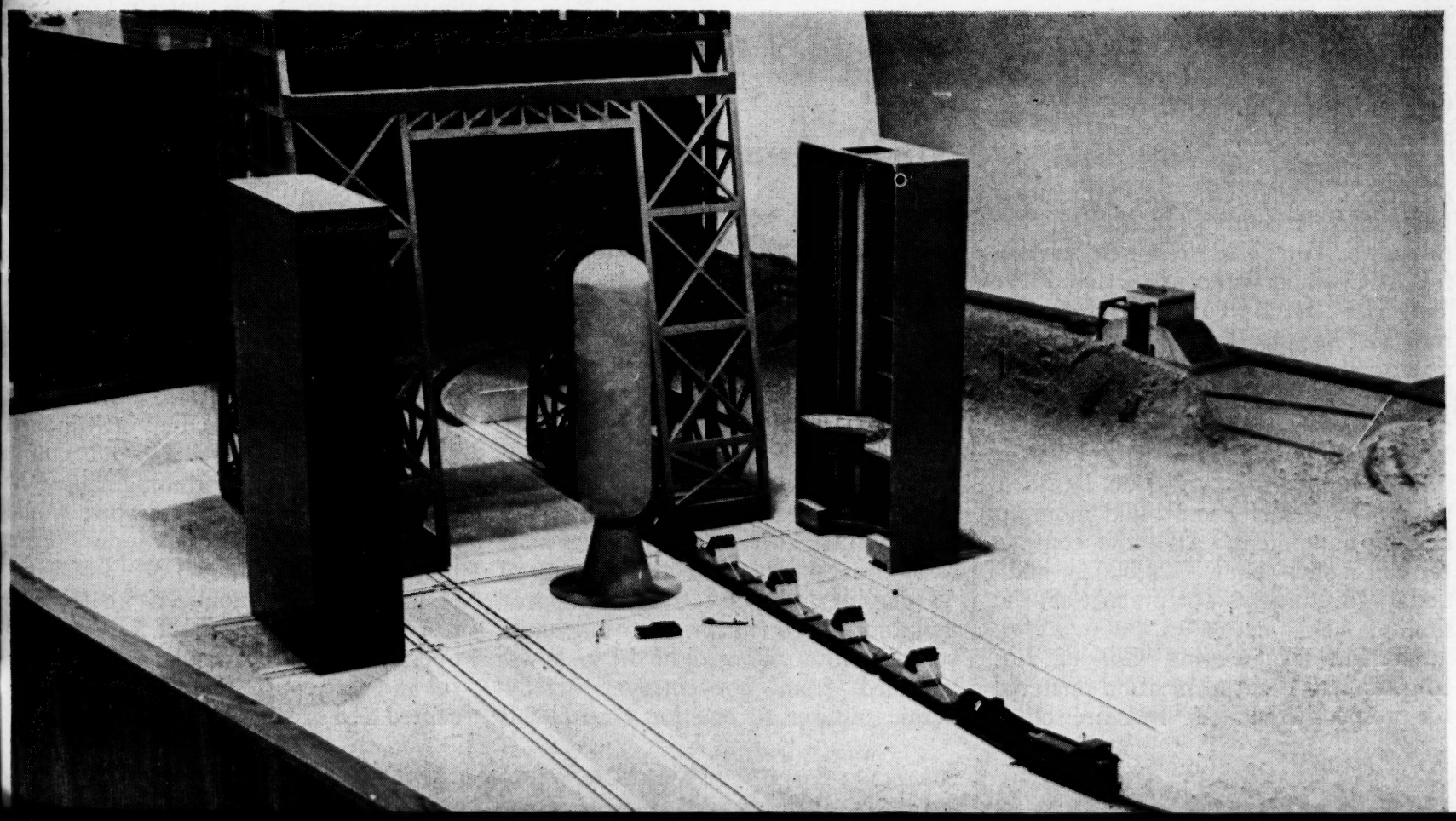
Conceptual Space Designs Shown at Rocket Society



Grumman OAO (Orbiting Astronomical Observatory) is shown in first full-size representation of the design. Huge paddles are solar cell arrays for power collection.



Aerojet Nerva engine model shows basic layout of engine to be developed as first flying article in Rover program (left); Lockheed proposal for a nuclear-rocket test vehicle compatible with NASA's Saturn booster shows conventional cycle of hydrogen fuel pumped through nuclear reactor for heating and exhausted through nozzle (center, right). Hercules Powder Co. proposes on-site assembly of segmented solid rocket and nozzle, filament wound from servicing towers (below).



Saturn S-1B Booster Bids Invited

Washington—Twenty-seven prospective bidders have been asked to submit proposals by Nov. 8 for the design, development, manufacture and test of the Saturn S-1B booster configuration.

The S-1B is a cluster of two Rocketdyne F-1 engines, each with a thrust rating of 1.5 million lb. No pre-proposal bidders' conference will be held on the project, since all but seven of the prospective bidders attended a Saturn S-1 conference Sept. 26 (AW Sept. 18, p. 26).

Both S-1 and S-1B will be manufactured at the Michoud, La., facility, recently acquired by the National Aeronautics and Space Administration (AW Sept. 11, p. 30). The S-1 contract will be essentially assembly, and S-1B will be complete development and assembly.

NASA decided to split the Saturn boosters into two contracts, and to award both before the end of the year.

Bidders invited to make proposals on the S-1B who were not invited to the S-1 conference are Acoustica Associates, Inc., Curtiss-Wright Corp., Fairchild Stratos Corp., B. F. Goodrich Co., Pratt & Whitney, Radio Corp. of America and Space Technology Laboratories.

Companies invited to bid on both projects were Aerojet-General Corp.; American Machine & Foundry Co.; Avco Corp.; Boeing Co.; Brown Engineering Co.; Chance Vought Corp.; Chrysler Corp.; Douglas Aircraft Co., Inc.; Ford Motor Co.; General Dynamics Corp.; General Electric Co.; General Motors Corp.; Hayes Corp.; Kaiser Fleetwings, Inc.; Lockheed Aircraft Corp.; Martin Co.; North American Aviation, Inc.; Northrop Corp.; Packard Bell Electronics, Inc., and Republic Aviation Corp.

AEC Will Expand Site For Pluto Engine Tests

Washington—Atomic Energy Commission will spend $6 million to expand its Nevada test site so it can evaluate a flight-type reactor as the next step in the Pluto nuclear ramjet program.

AEC announced last week that the Tory IIA-1 reactor underwent tests Sept. 28, and Oct. 5 and 6. The commission did not disclose what power levels were reached, but advance plans called for testing the reactor at full power.

Tory IIA-1, AEC said, was tested for "about one minute," temperatures "in excess of 2,000F" were reached and emission of radiation was "negligible." Unofficial sources said the tests were very successful, but AEC did not characterize them.

Dr. Theodore C. Merkle, associate director of the Lawrence Radiation Laboratory, recently said that if the full-power Tory IIA-1 tests were successful, AEC would skip construction of the Tory IIA-2 reactor core and go directly into testing the Tory IIC flight-type reactor.

AEC has asked for bids to expand the Tory IIC testing facilities at the Nevada site. AEC will expand its air storage supply from 120,000 lb. to 1 million lb. capacity and build more air heating equipment. Also, the contractor will install about $500,000 in additional government equipment at the site.

Norman Engineering Co. of Los Angeles has the specification material for prospective bidders. Bids are scheduled to be opened Nov. 7 at AEC's Las Vegas office.

The Pluto nuclear ramjet engine is being developed to power Slam—Air Force's supersonic, low-altitude guided missile. Air Force hopes to get $41 million in Fiscal 1963 and $30 million in Fiscal 1964 for its part of the Pluto program. This would be a sharp increase from the $7 million appropriated for that project in Fiscal 1962 (AW, Sept. 4, p. 26).

Dr. Harold Brown, defense director of research and engineering, is now evaluating Slam. An ad hoc committee he named to evaluate the Pluto project finished its report last week. Development of Pluto through the flight test stage is expected to cost $500 million, with the Air Force spending $400 million and AEC $100 million.

North American X-15 Reaches 215,000 ft.

Edwards AFB, Calif.—X-15 rocket research aircraft was pushed to a record altitude of 215,000 ft. by Maj. Robert M. White on Oct. 11. The previous maximum altitude was 169,000 ft.

Despite a high overcast in the vicinity of the launch area over Mud Lake, Nev., which threatened to cancel this 20th powered X-15 flight, the rocket-powered craft dropped from the B-52 at 45,500 ft., 200 mi. northeast of here.

White established a climb angle of 35 deg. at full power with the speed brake deployed to prevent maximum speed buildup. Control of the craft was switched from conventional aerodynamic surfaces to reaction control jets when the 150,000-ft. altitude was passed.

Maximum speed attained was at engine burnout 79 sec. after launch at an altitude of 125,000 ft. Maximum speed attained was 3,477 mph. or Mach 5.01. The X-15 coasted to its maximum altitude while White maintained attitude with the reaction system. He also used this system to establish preliminary attitude on re-entry during which gravity forces built up to 4.5g. Maximum surface temperature was 900F. White experienced 2 min. of weightlessness during the ballistic portion of the X-15 flight.

Use of A-Bombs Seen In Hurricane Control

Washington—Weather Bureau scientists are planning to bomb hurricanes with high explosives—possibly including nuclear devices—in their search for methods of controlling or killing these destructive storms.

Dr. Francis W. Reichelderfer, chief of the bureau, emphasized that any such attempts are fraught with technical dangers as well as political dangers.

Politically, control attempts could backfire. As an example, Dr. Reichelderfer said that if some measures had been taken with Hurricane Carla, which last month struck the Texas coast, and the storm had veered toward Mexico, the repercussions would have proved embarrassing to the United States.

Zeus Destroyed After Second Test Launch

Pt. Mugu, Calif.—Second Army Nike-Zeus anti-ICBM to be launched from Pt. Mugu, Calif., was automatically destroyed at the end of first stage burning when at least one component of the weapon system failed.

The sequence of events was slightly different from the first Pt. Mugu test of the Western Electric-Douglas missile which also was destroyed after several seconds of flight (AW Sept. 18, p. 34).

In the second test, separation occurred but there was no ignition of the second stage. The destruct packages were triggered a moment later. An Army spokesman agreed that there must have been a second malfunction that caused a deviation from course because the range shortening caused by the failure of one stage to ignite would not have produced a hazard any greater than booster fall-out.

The Army announced that some test objectives were met. First stage operation and separation were successful and test control commands were accepted and executed.

Comsat Programs Pushed for 1962 Orbits

New York—By the end of 1962, the U. S. hopes to have four different active communication satellites and several passive types in orbit: Defense Department's Project Advent, American Telephone & Telegraph Co.'s Tel-Star (new name for satellite formerly known as TSX), the National Aeronautics and Space Administration's Project Relay, built by Radio Corp. of America, and NASA's Project Syncom, built by Hughes Aircraft Co.

New details on the Defense Department and NASA communication satellite programs and schedules were disclosed here during the American Rocket Society conference last week.

First of three Advent satellites intended for low-altitude circular inclined orbits of approximately 6,000 mi. is scheduled for launch by an Atlas/Agena-B vehicle next summer from the Atlantic Missile Range.

Objective will be to obtain flight test data on performance of major satellite subsystems such as the attitude stabilization system.

These will be followed by high-altitude orbit launches using an Atlas/Centaur. The first two of these will use direct injection which is expected to permit siting the satellite at 22,300-mi. altitude along the equator at approximately 105 deg. west longitude, Dr. George E. Mueller, vice president of Space Technology Laboratories, told the ARS.

'Walking' Orbit

If successful, the next step will be to use a "walking" or "drift" orbit which enables a satellite to be placed at any longitude around the globe. This involves placing the Centaur initially into an elliptic orbit, whose period is slightly less than 24 hr. so that the satellite effectively drifts east relative to the earth.

The Centaur will again be fired when the vehicle is over the equator, initiating the walking orbit until the satellite is at the desired longitude at which time its hot gas propulsion is used to halt motion relative to the earth.

First Advent launch by an Atlas/Centaur to synchronous orbit is not expected to take place before mid-1963, Victor F. Evans, deputy assistant director of defense research and engineering for communications, told the ARS.

In reply to a question about reports that the Advent satellite was over its design objective weight of 1,000 lb., Evans said that figures as high as 1,272 lb. have been projected, but the weight is expected to drop to the target figure by the time of launch.

The AT&T Tel-Star satellite is scheduled for launch during the second quarter of 1962, followed by RCA's Project Relay in the third quarter and the Hughes Syncom in the fourth quarter, NASA's Daniel G. Mazur reported. Tel-Star is expected to weigh about 160 lb., relay about 120 lb. and Syncom about 60 lb., Mazur said.

Advent Details

The complete Advent satellite will provide two two-way radio channels, each capable of handling 500,000 bits per second of data or 12 voice channels. Satellite transmitter radiated power will be one watt. Electric power totaling about 600 watts will be provided by solar cells, with storage batteries provided for use when vehicle is in earth's shadow.

Infrared sensors will be used to keep solar cell paddles aligned with the sun, while other infrared sensors will serve to keep the satellite antenna aligned with the earth, hopefully to within two degrees of the vertical. Motor-driven inertia wheels and a cold (nitrogen) gas propulsion system with nozzles distributed over satellite surface will provide the motive power for vehicle stabilization.

Movable shutters on the satellite will be thermostatically controlled to maintain internal temperature between 50F and 70F, Mueller said. Crossed dipoles will serve as antennas for telemetry, tracking and command. A horn antenna will be used to receive earth transmissions and a 20-in.-diameter parabolic antenna will serve for transmission back to earth at a frequency offset from the earth transmission.

All components in the Advent satellite will be solid-state devices except for the final output tubes of the transmitter. Both the satellite radio receiver/transmitter and the ground stations will incorporate provisions intended to minimize the possibility of jamming, Mueller said.

System Configuration

To provide reliable communications service to areas of primary interest to the Defense Department, Mueller indicated that a system consisting of four satellites, two in synchronous equatorial orbit over the Pacific Ocean and two over the Atlantic Ocean, might be the first operational Advent system to be implemented. The two Pacific satellites would be placed at approximately 170 and 180 deg. west longitude, while the Atlantic satellites might be sited at 20 and 30 west longitude. The use of two satellites positioned in close proximity would assure continuous communications coverage in the event one satellite malfunctioned, while the 10-deg. separation between satellites would prevent signals intended for one from being received by the other when both were functioning.

In addition to three types of active satellites planned for launch next year by NASA, the agency also plans to orbit several passive communication satellites. One launch, planned from the Pacific Missile Range, will be a low altitude orbit of a 100-ft.-dia. Echo II, to test lifetime, rough sphericity and effect of radiation pressure on the orbit. A Thor/Agena-B will be the launch vehicle. Another experiment calls for orbiting three passive structures equally spaced in orbit at 1,500 to 1,700 mi. altitude for more detailed lifetime studies and to evaluate usefulness of passive satellites at the higher altitudes, Mazur said. Present plans call for launch from PMR, possibly into a polar orbit, using an Atlas/Agena-B. Satellites themselves may be rigidized spheres or other types of structures capable of providing modest signal gain.

Comsat Planning

A proposal that all government departments, agencies and bureaus analyze the possible application of communication satellites within their own fields, and prepare short- and long-range programs to serve as guidelines for a government panel of experts which would be formed to study required frequency allocations, will be introduced when Congress reconvenes in January, Sen. Warren G. Magnuson (D.-Wash.) told the ARS conference. ". . . If communications programs to the underdeveloped areas of the world will provide information and instruction that will enable the peoples living in those areas to increase their own food production, improve their living standards and their health, acquire technical knowledge they have not possessed before and enable the uneducated millions to read and write, and help them protect themselves against the most disastrous effects of typhoons and floods, these many objectives of our vast and costly foreign aid program will be in a measure achieved, thus permitting a reduction in the annual billion-dollar appropriations for this assistance.

"Possibly the savings in this area might offset the costs of global satellite telecommunication services. But . . . it is certain that this government would derive rich dividends in good will, in friendship, and in understanding, all of which may be crucial to our success in the world struggle . . . ."

DOD Seeks Single SAC-Polaris Command

By Larry Booda

Washington—Unified strategic command which would combine the Air Force Strategic Air Command and the Navy's Polaris missile submarine and attack aircraft carrier fleets has been proposed to the President by Secretary of Defense Robert S. McNamara. No decision has been announced.

The combination would be the force which fits the "package program" definition of Central War Offensive Forces. The first major move in this direction came Sept. 19 when the unification of the Tactical Air Command and the Strategic Army Command was announced. TAC-STRAC fulfills the definition of General Purpose Forces.

Package programs were sent to the services as guidelines in preparation of the Fiscal 1963 budget (AW July 24, p. 34, July 31, p. 24). They proposed a total Defense Department budget of $52.5 billion, but McNamara has told the services verbally that he expects to reduce the sum by $2.5 billion and instructed them to do their own trimming.

Assistant Secretary of Defense (Comptroller) Charles J. Hitch has already begun action to revise the program packages radically by next spring. This will be accompanied by further force unifications.

More Mergers Expected

Indications are that a Continental Defense Command, a Sea Defense Command (anti-submarine warfare) and a Supply and Support Command will be created in the near future.

Already in existence are the Defense Intelligence Agency, Defense Supply Agency, Defense Communications Agency and the Defense Atomic Support Agency. The first three are of relatively recent origin.

Eventually, no service will have direct operational control of any of its combat forces. This has already happened to the Air Force. SAC reports directly to the Joint Chiefs of Staff, and now TAC is in a unified command. The Navy has fought any encroachment of its control of Polaris submarines, insisting that they are an integral part of fleet operations. The attack carrier forces are in a gray area, having both a nuclear offensive mission and ability to perform troop-support functions. They were not included in the TAC-STRAC unification, however.

As they were sent to the services, the program packages were for Central War Offensive Forces; Central War Defensive Forces and Civil Defense; General Purpose Forces; Sealift-Airlift; Reserve and National Guard; Research-Development-Space; Service-wide Support; and the Department of Defense. DOD appropriations include funds for the agencies mentioned above.

The defense budget process has been speeded up for Fiscal 1963. In the past, guidance has been sent from DOD to the services about the middle of August, allotting them about six weeks to prepare submissions.

This time, however, the services were busy preparing program package data for the defense comptroller. Guidance was received early this month in the form of a document which outlined more than 300 weapon systems, forces and programs under the eight package categories.

Each service thus must act rapidly. Its policy-setting group must settle internal conflicts and then the working level prepares the submission for transmission to the Secretary of Defense by 8 a.m. Oct. 23. There is some doubt whether all the services will be able to meet this schedule. Requests for delay are expected.

Service submissions will be in the standard category form such as personnel, operations and maintenance, procurement, construction, public enterprise funds, research, development, test and evaluation and military assistance. After they are returned to DOD they will be re-converted to the program form by Nov. 15.

No change in the category form in which the budget goes to Congress is anticipated because the controls exercised there over service spending would be radically changed if the document were submitted in program form. Programing, however, will remain as a tool of the executive branch.

Next step is final review by the Secretary of Defense and transmission to the Bureau of the Budget. From then until final approval by the President there is a constant flow of correspondence and conferences to settle differences between the Bureau of the Budget and DOD. These changes, suggested or mandatory, are passed back to the services to be worked out.

Ordinarily, final approval is forthcoming the first week of December and the budget document goes to the Government Printing Office. The final approval goal date this year, however, is Dec. 15. There is considerable doubt whether this deadline will be met. The budget document for the entire executive branch must be printed and ready for submission to Congress by the statutory date of Jan. 20.

There are indications that many adjustments will be made to the $50-billion goal. Principal change will result from further cost effectiveness scrutiny of weapon systems. Distribution among the services will be roughly $20 billion for the Air Force, $15 billion for the Navy, $12 billion for the Army and the remainder divided equally between military aid and DOD.

Reduction in Manpower

Although defense spending will rise sharply—about $4 billion above Fiscal 1962 if current goals are kept—manpower will be reduced by 147,270. This figure indicates that the reserve and National Guard personnel called up during the present fiscal year for 12 months active duty will be released, unless the international situation does not improve.

The Air Force would have 848,000, a cut of 51,170; the Navy 640,000, a drop of 17,100; the Army 929,000, a cut of 79,000; and the Marine Corps 190,000. The Marine Corps is presently building its strength to that figure.

Most drastic cut in a program goal was in the fixed-site Minuteman solid propellant intercontinental ballistic missile. Air Force originally suggested a program of 2,500 of these missiles through 1967 and $1.3 billion for Fiscal 1963. The over-all goal has been adjusted downward to 900 missiles, but the Fiscal 1963 funds have been boosted to $1.8 billion.

Navy goal of 45 Polaris submarines during the same time period has been cut to 41. A total of $2 billion will be requested for Fiscal 1963 for this weapon system.

TFX Bidders' Conference

Preliminary bidders' conference on the Air Force-Navy TFX tactical fighter was scheduled for today at the Aeronautical Systems Division, Wright-Patterson AFB. Bids for the twin-engine, variable geometry wing aircraft are due Dec. 6 (AW Oct. 9, p. 24).

Companies which plan to enter the competition are the teams of Convair and Grumman, and Republic and Chance Vought, along with the individual companies, North American Aviation (combining the Downey and Columbus divisions), Douglas, Boeing and Lockheed. Each of the teams combines Air Force with Navy production experience.

Powerplants considered capable of meeting the specifications are the General Electric MF295, the Allison AR168 and the Pratt & Whitney TF30. Details of the engines have not been revealed but they all are in the 10,000-lb.-plus class.

No funds are included for additional purchases of the B-52 and B-58 heavy bombers and the B-70 Mach 3 bomber is programed for airframe development only. For the current fiscal year, Congress voted extra money to cover these items. McNamara recently stated that in view of the overwhelming congressional vote for these funds he was restudying the matter. No decision has been announced.

The Convair F-106 air defense fighter is included in the 1963 budget request, but only as a tentative item. Air Force had requested 200 of them. The decision may be affected by the outcome of Project Highspeed, a series of comparison tests between the F-106 and the McDonnell F4H (AW Oct. 9, p. 21).

Conventional Carrier

One conventionally powered aircraft carrier will be budgeted for the Navy every other year. The Navy's Typhon missile system is due for critical examination, not because of its technical capabilities, but because of cost.

Army's Nike Zeus anti-missile missile will be continued as a development program only. However, re-examination may lead to a decision to begin current production of long lead time components. Army will be limited to 14 divisions, a cut of two from what was requested.

Army aviation will be budgeted for additional orders of Beech L-23F twin engine transports, Hiller H-12 and H-23D helicopters, 325 Bell HU-1 turbine-powered helicopters, 26 de Havilland AC-1 twin-engine STOL transports and 40 Grumman AP-1 twin turboprop reconnaissance aircraft.

The Air Force will be scheduled for 400 Douglas A4D attack aircraft to be used in tactical troop support. This is an interim purchase pending development of a new close support aircraft, the VAX, (AW Oct. 9, p. 24).

Super Scout Proposed

Super Scout—a standard Scout rocket initially lifted by an Aerojet-General solid-propellant booster—is being proposed by Aerojet as one of several means to improve the performance of the test and research vehicle.

Calculated to be capable of placing a 1,000-lb. payload in a 300-naut.-mi. orbit, Super Scout is an outgrowth of studies made by the company aimed at upgrading the propulsion system of the vehicle.

Aerojet's plan started as a means of improving payload capability of the Scout without changing its existing shell. First approach was substitution of advanced solid-propellant engines to double the payload capacity of the vehicle.

Second step was to add a 25-ft.-long first-stage booster to produce Super Scout. The new vehicle would weigh 98,220 lb., including its 1,000-lb. payload, and would stand 99 ft. high.

Third step in the proposal would add a guidance package to go into orbit with the Scout payload—now spin-stabilized rather than guided—and this layout would be called Scout 2. Payload capability would be 1,400 lb. in a 300-naut.-mi. orbit.

Other current plans to improve Scout include a contract held by Allegany Ballistics Laboratory to improve its two engines in the four-stage Scout, and a proposal by United Technology Corp. for a six-stage Senior Scout.

Project West Ford Is Approved After Study

Washington—Air Force will proceed with Project West Ford and shortly will attempt to place in orbit 75 lb. of thin hair-like filaments expected to form a narrow belt of dipoles which will reflect microwave signals for beyond line-of-sight communications experiments.

A special panel of the President's Science Advisory Committee, formed to restudy the possible adverse effects of the West Ford experiment after protests voiced during the recent International Astronomical Union meeting, has concluded that the Project West Ford experiment will not impair radio or optical astronomy.

In reply to a recent protest by Soviet scientists that the belt of filaments would pose a physical hazard to manned and unmanned satellites, the panel says that vehicles capable of withstanding micrometeorites are amply protected against collision with the filaments.

The panel's report restates the government policy announced on Aug. 8 that no further launchings or orbiting dipoles will be made until results of first experiment are fully analyzed.

The panel of top astronomers and physicists concluded that 100,000 times as many dipoles as are planned for the West Ford experiment would have to be released to adversely affect or interfere with radio/optical astronomy. Within two months after filaments are placed in orbit, they will have spread sufficiently to increase brightness of the darkest part of the night sky by less than 1%, and this only in a very limited portion of the sky at any instant, the panel concluded.

The weight of filaments to be launched, and the polar orbit selected will assure that substantially all of the filaments will have returned to earth within four to eight years, the panel study indicated.

News Digest

Kaman Aircraft Corp. is surveying corporate aircraft owners to determine the market potential of an executive helicopter. Two designs are being proposed, one a five-place ship with a 200-mi. range and 130-kt. speed and the other a six-place, 300-mi. range, 150-kt. ship. Both would be powered by a single turbine engine. Prices would range from $90,000-$300,000 depending on equipment, and would have operating costs of $75 an hour based on 600-hr. annual operation.

National Assn. for the Advancement of Colored People last week accused Douglas Aircraft Co.'s Charlotte, N. C., plant and Western Electric Co.'s Nashville, Tenn., distribution center of practicing job discrimination. Both defense contractors have signed anti-discrimination pledges prepared by the President's Committee on Equal Employment Opportunity. Douglas denied the charges while Western Electric declined to comment pending an investigation of the charge.

C. M. Woodhouse, 44, has been named parliamentary secretary for the British Ministry of Aviation by Prime Minister Harold Macmillan in a shuffle of administration officials. He replaces Geoffrey Rippon who will become joint parliamentary secretary for the Ministry of Housing.

Stockholders of the Martin Co. will receive 1.3 shares of the new Martin-Marietta Corp. for each share of Martin stock now held and stockholders of American-Marietta Co. will exchange their stock on a one for one basis.

Maj. Gen. James Ferguson, vice commander, Air Force Systems Command, has been named to succeed Lt. Gen. Roscoe C. Wilson, deputy chief of staff, research and technology, Air Force headquarters. He will assume the post, with three-star rank, on Nov. 30, the date Gen. Wilson retires.

Several new advances in optical masers have been reported by Bell Telephone Laboratories. One is a new material, neodymium in calcium tungstate, which emits light at 10,600 angstroms with an input power of only five joules at room temperature. Another is a technique for greatly increasing intensity of optical maser emission by using external mirrors with a chopper wheel placed in front of one mirror instead of silvering the ends of the ruby rod.

Delta Sees Added Potential in New Routes

Increased space activities on Delta's southern transcontinental routes may enhance carrier's position.

By Glenn Garrison

Atlanta—Delta Air Lines, busy expanding services on its new southern transcontinental routes, expects to profit by a rapid economic growth in the areas it serves and thereby to enhance its relative position in the airline industry.

Delta's route pattern, in the view of President C. E. Woolman, includes areas whose economic development is moving faster than that of the U. S. in general. This should increase the airline's share of over-all air traffic. Delta's share of the industry total increased 26% last year to 6.3%.

An example of the economic potential on Delta's routes is New Orleans, with nearby Michoud, La., selected as the site for a Saturn booster production base and possibly for assembly of the Nova launch vehicle. Delta's southern transcontinental route and its routes to the north and southeast tie in to New Orleans.

Another space activity with high traffic potential will be located at Houston, where the National Aeronautics and Space Administration's $60-million Manned Space Flight Laboratory will be located. Delta does not serve Houston on its transcontinental runs, but does connect the city with the Midwest and Northeast.

The airline with its new routes also has access to the electronics and space industries on the West Coast, which tie in with the East Coast activities including Cape Canaveral. Delta formerly served the West Coast through an interchange agreement with American Airlines, which automatically ended when Delta's own authority became effective.

This interchange, enhanced last year by jet service with Delta's DC-8s between Atlanta and Los Angeles via Dallas/Ft. Worth, eased Delta's transition to a transcontinental operator. Especially, it aided Delta's establishment of an identity in West Coast markets.

Delta's new southern routes have shown a 52% load factor since inauguration of first schedules June 11. With the delivery of new equipment, the airline this month is making a major expansion of the southern transcontinental services.

Even without the new and potentially profitable routes, Delta's financial health has been favorable in a period when the airline industry is economically depressed. A major factor has been Delta's equipment leadership in its important markets, where it got an early lead with jets.

Delta earned a net profit of $4,651,836 including sale of piston equipment during the year ended June 30, up from $2,839,083 the previous fiscal year. Operating revenues for the two years totaled $146,132,333 and $120,191,225 respectively.

Results for July and August, traditionally slow months for Delta, were a net after taxes of $137,000, as opposed to a small loss for the same two months of 1960.

But competition will be tougher from now on as the airline's competitors add jet schedules with the expansion of their fleets.

In addition to the economic growth areas on its routes, however, other factors favoring Delta's position, Woolman told AVIATION WEEK, are:

- **Long-haul routes** which are suited to jet operation. In addition to the newly acquired southern transcontinental routes, Delta serves Puerto Rico and Caribbean points including Caracas, Venezuela. Delta therefore has a good opportunity to attain maximum use of its long-haul jet capability.
- **Personnel stability** and a fortunate situation in the pilot-engineer disputes which grounded Delta's competitors on several occasions. Delta's engineers are pilot-trained and were not involved in the cockpit controversies. Delta shows strong pride in the continuity of its management and personnel.
- **Equipment decisions** which enabled Delta to skip the turboprop phase. Operation of turboprops by the competition and the attendant difficulties was an industry problem that Delta was not beset with, Woolman said.

The long-haul jet potential will be tapped Dec. 1 when Delta plans to inaugurate once-weekly through-plane jet service to Caracas from San Francisco via Dallas, New Orleans and Jamaica. Plans also call for early jet service to Puerto Rico.

Turboprops were regarded by Delta as interim equipment only, Woolman said. Since speed was what the airlines were selling, Delta went directly to Convair 880s for routes competitive with turboprops.

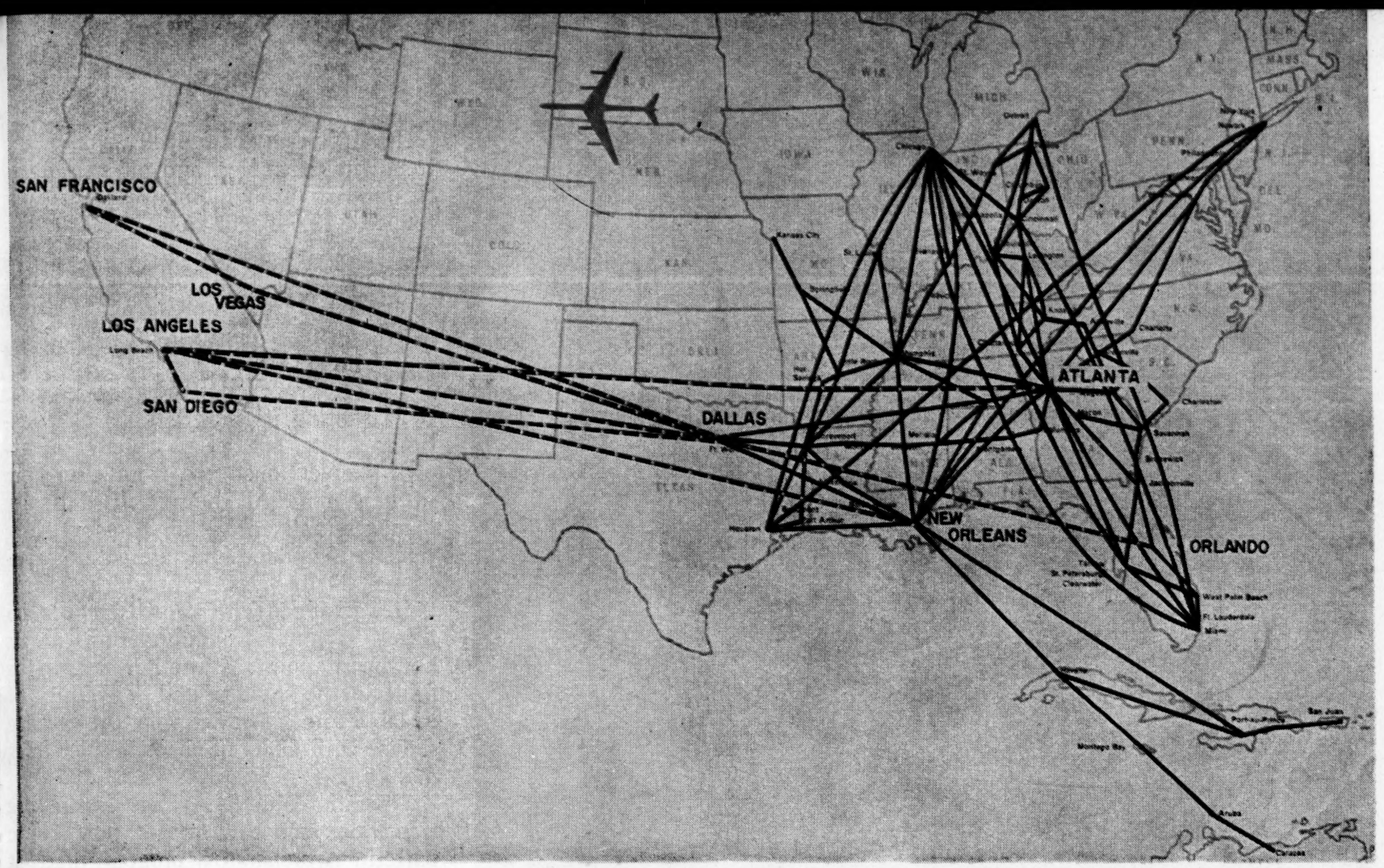
Delta anticipated the competition would have about a year's advantage because of earlier deliveries of the turboprops, according to Woolman. As it turned out, Delta's volume was not affected as much as expected.

Of Delta's competition from the merged United instead of the old Capital, Woolman said "It has put a more vigorous competitor into a field that is amply served without it."

The Delta president made these points concerning the industry situation in general:

- **Major industry problem** is overcompetition over many routes. Capacity can't be cut back too much because of the competitive situation, so overcapacity results. Woolman was voicing a major complaint brought up at the recent meeting of 13 airline presidents with the Civil Aeronautics Board (AW Oct. 9, p. 37).
- **Promotional fares** are too varied and the result is a structure complicated to administer. Most of the fares don't really tap new markets, but there are exceptions such as some family plans and off-season package deals. Woolman joined the critics of the recently introduced youth fare plan and said he didn't believe anybody really thought it was a good idea.
- **Airlines will improve** their position as the economy of the country improves. Air travel will continue to grow, but there's a limit to the market it can be expected to tap.

On the southern transcontinental routes, Delta last week was scheduled to inaugurate its first service at San Francisco, which will be scheduled from Atlanta via Dallas and New Orleans. As of Oct. 29, the transcontinental daily round trips will total seven, including two 880 schedules originating in Orlando, Fla. One DC-8 nonstop between Atlanta and Los Angeles, already operating, is included in the total. All of the schedules will be jet except a DC-7 round trip between New Orleans and Las Vegas via Dallas. Delta's four West Coast points are San Diego, Los Angeles, San Francisco and Las Vegas. One of the schedules will provide Birm-



TRANSCONTINENTAL routes across southern tier of states, shown in dotted lines above, added 25% to Delta's unduplicated route mileage. Four West Coast cities were added to Delta's system: San Diego, Los Angeles, Las Vegas and San Francisco.

ingham, Ala., with its first jet service.

To cope with this 25% expansion of its unduplicated route miles to a total of 14,122, Delta recently placed a follow-on order for four additional 880s and three turbofan DC-8s, all of which are scheduled for delivery next year. A previous additional order of three 880s will be completed this year—two have recently been delivered and the third will be received next month. This brings the total 880 fleet this year to 12 airplanes and the DC-8 fleet now totals six. Delta also operates a piston fleet of 20 DC-7s, 11 DC-6s, 26 Convair 340s and 440s, and five cargo C-46s.

Financing for the seven airplanes to be delivered next year has not been completed. It is under consideration now, but no final conclusion has been reached, according to Todd G. Cole, executive vice president-administration.

Retrofit of Delta's present DC-8s to the turbofan Pratt & Whitney JT3D engine is a possibility for the future. But no decision has been made.

A report that Delta was planning equity financing with 250,000 shares of common stock to be sold at $36-37 a share was denied by Cole. Delta has no firm plans at present for equity financing, he said. Such a move is, however, under consideration because Delta thinks it desirable to broaden its equity base.

Delta can finance its new equipment without equity financing, but relatively high market prices for its stock now are an encouragement to improve its debt-equity ratio.

In activating the new West Coast routes, personnel expansion has not been a major problem, Cole said. About 75 pilots have been added to Delta's roster in the past 12 months. However, the routes plus fleet expansion have increased Delta's over-all payroll by 723 employes since the beginning of last fiscal year to 8,290 at the end of June.

Initial experience on the new routes indicates that the CAB estimate of $30 million in annual revenues is reasonable, but competitive factors could change the expectations. Delta's prospects for the coming year depend on "the great unknown"—load factors—Cole said. The major industry problem of overcapacity will be solved in time with growth of the market, he said, if CAB exercises restraint in future cases.

With Delta's new West Coast routes making up about 15% of the airline's total market as of June, 1961, other markets on Delta's route pattern broke down about as follows: Midwest over various routes to Florida, 33%; Detroit and Chicago down to Houston over routes that include such cities as St. Louis and Memphis, 17%; Atlanta to New York, 15%; Atlanta-New Orleans-Dallas, excluding the West Coast; Chicago to Houston and Chicago to New Orleans, 4%; the Caribbean, 2%. Expansion of new segments, of course, is shifting these percentages.

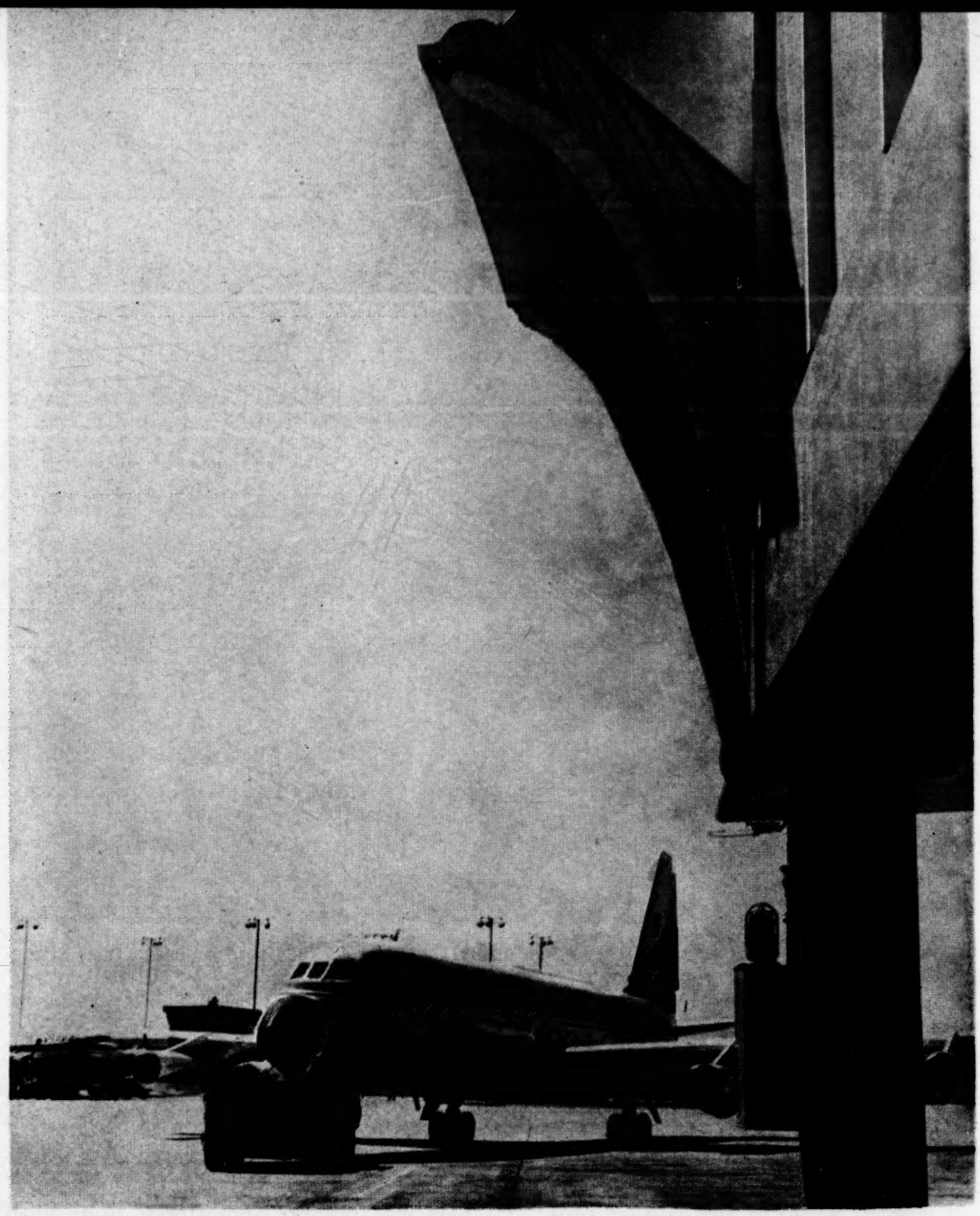
Delta underwent another major route expansion in 1956, when it entered the New York market. This was tough going for a while, according to Charles P. Knecht, assistant vice president-sales. Delta lacked identity in the area and the destinations it served from New York were not the big ones. A major advertising effort was undertaken by Delta to get established in the market.

One big boost for Delta's New York operation occurred in October, 1957, when the carrier had been in the market about two years. Delta had just established a plush "Royal" DC-7 service, and was having operational bugs with it during the first two weeks. Just as it straightened out, Capital went on strike, followed shortly by Eastern. With these two major competitors knocked out and Delta "putting its best foot forward" with a plush service, Delta acquired a strong foothold in the market which, according to Knecht, has been expanded and enlarged upon.

Delta put DC-8s into the New York-Atlanta market in September, 1959, and shortly afterward phased the jets into its service from Chicago and Detroit to Miami and to Houston and Dallas/Ft. Worth. This gave Delta a long lead with jets over Eastern in the Florida market. Convair 880 service was inaugurated in May, 1960, again putting Delta out in front with jets in its North, South and Midwest markets.

The 880s until now have been operated in an all-first-class configuration, but Delta is planning to add coach seats in the near future. They will still be predominantly first class, with 56 first and 32 coach seats compared with the present 86 first-class seats. The coach section will contain six rows of five seats, three and two abreast, and one pair of seats opposite a coat room in mid-section.

Knecht says Delta's relative emphasis on first class over coach traffic—Delta was one of only two carriers in June offering more first class than coach



CONVAIR 880 is pushed out for departure at Atlanta. Delta's "jetway" covered loading bridge, above, is now at Atlanta, Idlewild and Miami, will be installed at other stations.

capacity (Braniff was the other)—reflects in part Delta's percentage of short-haul services and relative lack of high-density points. Also, its markets have generally been suitable for first class, with a large proportion of business travel. This has been true, for example, in the New York-Atlanta market.

But this market within the past few months has reflected the trend of companies to require coach travel where available, Knecht said, so Delta has been studying a suitable reaction to the trend. Lists from Los Angeles of which companies now require coach reads like a "Who's Who" of industry, Knecht said.

Coach Travel Trend

However, Knecht questions whether the trend toward requiring coach travel actually is beneficial to business. Because of the additional space allotted a first-class passenger, the businessman has more room to work or relax for his destination job. Rather than a blanket rule by a company, in this view, requirements should be made on an individual basis. Knecht says there is already some reaction in this direction by business travelers.

The West Coast routes having made a national carrier of Delta, its advertising will now reflect the new status. More advertising will be done on a national scale, in magazines. To prepare for the new service, Delta added about $450,000 to its advertising budget to promote the southern transcontinental runs. On the West Coast, "Delta to Dixie" has been the theme, stressing service and Southern charm. To the West, emphasis is on "all the way with Delta."

Delta has consistently made efforts to sell its Caribbean and Caracas destinations on the West Coast, and considers this market a strong long-range potential. Hotel registrations from California in Puerto Rico, Knecht said, showed up in a recent survey second only to New York, and Jamaica also reflected strong California business. But the situation in Havana and general political problems in the area presently inhibit this potential: the Caribbean routes now accounting for only about 1% of Delta's revenue passenger miles, whereas they have contributed as much as 6%.

The Florida market has been relatively weak for some time, but Knecht says these are "straws in the wind" indicating an improvement next winter. Delta has in any case been bucking the trend: its Miami on and off passengers for January through August of this year totaled 318,540, up from 296,720 during the same period of 1960. More than half of Delta's Florida recreational traffic comes from the Chicago, Detroit and Cincinnati points.

West Coast Staffing

In staffing its new West Coast stations, Delta has relied chiefly on its own people transferred from elsewhere in the system. All the new district sales managers fall into this category. By transferring traffic and reservations personnel, Delta feels, it provides a force better equipped with knowledge of such things as hotel accommodations at its Southeast points. Another reason is pride in the stability and continuity of its labor force. For example, the average service with Delta of all its district sales managers is 15 years.

Operationally, Delta has made the transition smoothly to its new route pattern. A preparatory program made it unnecessary for the Federal Aviation Agency to require route-proving checks. Prior to the first schedule, nine Delta DC-8 captains and five 880 captains flew as scheduled extra crews on the American DC-8 interchange flights. They also qualified into Ontario, Calif. on Western Air Lines' flights between Los Angeles and Ontario, the latter airport being an alternate. Dispatchers were sent to the stations, flying the routes involved. En route communications were established by contract with American for use of ground facilities, and Delta is now buying American's ground communication facilities in the area.

Delta was first into service with the DC-8, just a few hours ahead of United, and well in the lead with the 880, leading Northeast and TWA by about eight and nine months respectively.

The two jets "ran pretty much neck and neck" in ease of going into service, according to C. H. Dolson, vice president-operations.

The 880, Dolson says, requires extra pilot training time because of its high-performance rate of climb and steepness of climb. But for various reasons, including the fact that Delta's 880 instructors had DC-8 experience, the average transition time for captains in both aircraft has run about the same, at 18 hr. Delta has an 880 simulator, but no DC-8 simulator; however, many pilots were given DC-8 simulator time on rented United equipment, Dolson said.

Delta expected to get its last 880 late this month, prior to actual delivery date, for guaranteed performance tests. These are to be performed on the final instead of the first airplane, Dolson said, because the airline wanted to put the 880 into service as quickly as possible. Dol-

son said he expected the test airplane to meet guarantees. It is, however, a modified airplane from the earlier deliveries.

Delta's 880s have just completed a modification program that kept one aircraft out of service from May 1 to Sept. 26. This work, performed by Convair at Delta's Dallas facility, involved about 200 items. In addition to airframe modifications, engines were retrimmed, partly at Dallas and partly at Delta's big base at Atlanta. The engine retrimming, which improved hot day and specific fuel consumption performance, was scheduled to be phase one engine of the General Electric CJ805-3, with two more phases to follow. However, the follow-on planes next year, and the final plane this year, will be equipped with the CJ805-3A engine, and instead of completing phases two and three on the current engine, they will be modified to the -3A engine on an attrition basis.

Airframe Modifications

Airframe modifications included changes of the tail cone, with internal glass fiber beef-up to provide more mass for absorbing vibrations without metal fatigue (there had been some cracking of the tail cone), and beefing up of outboard foreflaps by laminating another layer of skin on them to eliminate cracking. Two airframe modifications in connection with the engine retrim were insulation of a throttle switch which deactivated the vortex destroyer, and a fix on the engine cooling jet pump. This eliminated some of the loss of bleed air and increased thrust.

A major modification item, Delta engineers said, was repainting the 880s. From an epoxy resin paint which required too-careful environmental control, the aircraft were repainted with enamel. The original paint would peel off and leave a "picked chicken" appearance, according to Delta.

The early 880s were not deficient in runway performance or in cruise speed, but required a higher power setting than planned to cruise at Mach .84 and hence a higher fuel flow.

Delta's DC-8s also went through a modification program, being returned to Douglas during a period beginning in the spring of 1960 and ending in mid-January of this year. These aircraft underwent the Douglas modifications including leading edge slots.

Because of the loss of airplanes to modifications and training, and also because of Delta's basic route pattern, utilization has not been particularly high on the airline's jets. However, the figures will increase from now on, according to the carrier.

For the DC-8s, utilization in 1960 peaked during April at 8.04 hr. and hit a low of 5.44 in July as overhauls began and as the airplanes started back for modification. The 1961 high so far was 8.15 hr. in June, and for the rest of 1961 the prediction is about 9 hr.

For the 880s, the 1960 peak was in September at 6.22 hr., when the carrier had five of the aircraft. The 1961 high was in April with 6.23 hr., and the prediction for this month, with 11 aircraft in service, is 7.27 hr.

Average Stage Length

Delta's current average system stage length is 280 stat. mi. Average 880 stage length is 665 mi. The 880s are operating at a cost of $1.62 per mile, while the DC-8 direct operating cost per mile is $2.01.

With its DC-7 piston equipment, Delta's utilization is running about 7 hr; with its DC-6s, about 8.45; and with its Convair 340s and 440s, about 7.15.

With the introduction of DC-8s, Delta set up a new maintenance system based on continuous blocks rather than recurring blocks. Instead of dividing overhaul into eight recurring blocks, representing division of a total number of hours, the blocks now are in an infinite series and are pegged to more nearly exact overhaul lives of individual components. This required a great deal of research to set up, but Delta says it more nearly utilizes the maximum time of each item.

Delta's giant jet overhaul base at Atlanta, opened in June, 1960, employs about a quarter of the airline's entire personnel total. Prior to the opening, Delta's DC-8 engines had been overhauled by American. The 880 engine overhaul from the start was done by Delta, and the DC-8 engines were phased into the work of the new base.

BOAC Disposes of BWIA

British Overseas Airways Corp. last week sold 90% of its wholly owned subsidiary, British West Indian Airways, to the government of Trinidad-Tobago for $1,456,000 (AW Oct. 9, p. 36).

The price included one of the five Viscounts BWIA operates, a small DC-3 fleet and BWIA's property in Trinidad. BOAC will continue to lease BWIA the other four Viscounts and will go on providing leased Britannias for a West Indies-New York service now operated by BWIA for the time being. BOAC will have a seat on the BWIA board.

Jamaica, which has voted not to join the West Indian Federation, is expected to designate BOAC as its chosen instrument. BOAC is retaining the BWIA property in Jamaica.

The future status of Leeward Islands Air Transport—a subsidiary of BWIA—was not spelled out, but presumably it will become part of the new West Indian-owned airline.

Lack of Liaison Major Cause of BOAC Strike

London—Major cause of a 12-day strike by British Overseas Airways Corp. employes at London Airport last July was lack of communications between the management and men, a special investigations committee reported last week.

The strike, which BOAC claimed cost the airline nearly $1 million a day, started when workers objected to a supervisory scheme which was the final step in streamlining the London operation (AW July 24, p. 23).

The committee, composed of four union executives and two BOAC agents, set up by the National Joint Council for Civil Air Transport, reported:

"It is imperative that a large measure or harmony and understanding should exist between supervisors and tradesmen [i.e., workers] . . . and both groups [are urged] to make every effort to improve the present relationship."

Discussing the lack of communication, the committee said many of the witnesses were ill-informed on the new supervisory system, its objectives and the short- and long-term effects of its introductions—circumstances which the committee claimed facilitated the spread of false rumors.

Although the committee said BOAC did little to give the complete picture to the workers, the group also criticized union leaders for not effectively reporting the facts to union members. Another problem is what the committee called antagonism between the two worker groups—supervisors and their maintenance staffs.

Committee emphasized that, in its opinion, no group of workers has been adversely affected by the new supervisory system. However, the members recommended that BOAC should make further efforts to create training facilities leading to securing of licenses, and thusly potential promotions.

Liquidation Ordered For British Carrier

London—Overseas Aviation (C.I.), Ltd., British independent airline which is deeply in debt to Rolls-Royce, British Petroleum and British Overseas Airways Corp. (AW Aug. 28, p. 43), last week was ordered into compulsory liquidation on a joint petition by Rolls and British Petroleum.

Overseas Aviation, which has been grounded since British Petroleum cut off its fuel supplies, owes about $700,000 each to the fuel company and to Rolls. Also the airline owes BOAC about $300,000 for spare parts for Overseas Aviation's Argonaut transports.

Airlines Split on Dropping Frills; Some See Fare Increase Requests

By Robert H. Cook

Washington—Airline interest in a new round of fare increases was rekindled last week after it became apparent the carriers could not agree on the Civil Aeronautics Board suggestion to offset falling profits by cutting out "frill services" (AW Oct. 9, p. 37).

Only one week after completing a "general agreement" to drop all food and liquor service on coach flights, nearly half of the 11 major trunklines were skeptical about the savings this would produce, while others were clearly reluctant to abandon a competitive weapon on which they have built their identity and success.

Most carriers had no definite idea of how much their operational costs would be reduced by dropping these services, but they indicated it would hardly be enough to alter profits significantly. Catering and airline kitchen costs for first-class service would still account for most of the more than $67 million spent by the airlines for passenger food service last year.

Agreement Doubted

Airline presidents and management personnel appeared doubtful that industry will reach accord on the idea. The refusal of any one direct competitor will be enough to doom the proposal, they point out.

"In the final analysis, the one missing link in this picture is the public," said the president of a major transcontinental carrier. "We've got to give them what they want and I doubt if either the airline industry or the CAB is going to make any arbitrary decision on this."

Substituting a sandwich type meal for a hot meal on coach flights, as originally suggested by CAB, would save "nothing more than the cost of a little electricity," he said. Another idea—selling coach passengers box lunches at the airport—would return the industry to the lower quality of service prevalent several years ago, he said.

The executive said he believed the CAB may soon be asked for permission to discuss actual fares—a subject which Chairman Alan S. Boyd was careful to emphasize would not be discussed at any airline management meeting approved by the Board.

New Request Expected

"If the Board doesn't agree to this, someone is almost certain to get at the root of our profit problems by filing tariffs for a new fare increase," he said. This opinion is shared by several other trunk operators, he added. The rapid acceptance of lower coach fares and their diversionary effect on the higher-yield first-class fares is a major cause of the industry's plight, he said.

Other carriers supported the idea of a fare increase, but were divided on whether it should be applied to coach or first-class service. Most favored a higher charge for coach, pointing out that it gives the passenger the same speed advantage, with similar meals and nearly the same comfort. Cost to the airline is close to that of first-class service, but yields a lower profit. They estimated coach fares should approximate 85% of the first-class charge. However, they seemed doubtful that the CAB would relent in its policy of keeping coach fares at the fixed 75% level.

Another transcontinental airline spokesman said he favored higher first-class fares to offset the diversion, but feared that increasing them might only accelerate the exodus to coach. He said it would be "extremely difficult" to put a dollar value on how much could be saved by dropping meal service on coach flights, but that he "went along with the general idea" as a possible means of streamlining its operations.

Another View

Another trunkline, which said it favors a "modest" increase in coach fares, thought that the dropping of food service for this class might be more significant if judged by the effect it might have on the industry's current earnings. Industry financial figures for the first six months of this year show a total net loss of $37 million, so that a saving of as little as 10% might make the difference between a profit or a loss for many airlines, an executive of this carrier said.

He added that his company might save nearly $3 million if it decides to cut out coach flight meals.

He expressed a hope that the industry would arrive at, and abide by, an agreement on the food problem, as this might prove to the CAB that the carriers can be trusted to solve much larger problems.

Meal service on turbojet flights was singled out by another airline president as a "never-ending headache" in that it has been difficult, on short flights, to provide the full service expected by the public.

"Once they're used to it, you've got to provide the service, but it has been extremely difficult to schedule and serve meals for consumption in sometimes less than an hour, for a route that used to take two or more hours on a piston aircraft flight," he said. This executive claimed there is "only one real holdout" against the idea of cutting coach meals, and saw a distinct advantage in the idea. Beyond the actual savings in food and catering costs, he noted the need for one less hostess.

Selling Point

Speed, rather than food, is "still the main thing we're selling" he said. He singled out night coach service revenues which he said have been severely affected by day coach fares, which are only slightly higher.

On the proposal to drop liquor service for coach passengers, some carriers commented that it is provided only as a convenience which generates very little profit.

Others, which do not serve liquor at all, pointed out "we didn't hire our hostesses to be barmaids."

1960 Passenger Food Expenses *

American	$15,995,900
Braniff	2,735,513
Capital	2,870,604
Continental	2,070,734
Delta	4,063,745
Eastern	8,387,305
National	2,198,723
Northeast	1,203,257
Northwest	3,236,475
TWA	7,794,909
United	11,336,520
Western	2,205,082

* Figures taken from official Civil Aeronautics Board Form 41 reports. Totals cover domestic operations only.

Northwest Combines All Customer Services

Northwest Orient Airlines has created a new transportation services department designed to consolidate all customer service functions in one operating section.

The new department, under the direction of Paul L. Benscoter, vice president-transportation services, consists of five divisions, each responsible for all phases of transportation contacts with Northwest's customers. Benscoter will be assisted by M. S. Brandjord as director-services administration.

M. C. Lund will direct the ground services division and J. C. Robertson has been named director of the in-flight services division. R. H. Weihe will head the communications division and L. J. White will continue as director-reservations division.

U.S. Carriers Slip in International Competition

Latest Civil Aeronautics Board figures show U.S. flag carriers' share of the international traffic declined 20% between Fiscal 1950 and 1960:

- In Fiscal 1950, there were 16 U.S. flag carriers and 41 foreign airlines competing for international traffic, giving the U.S. 28% of total number of airlines. In Fiscal 1960, there were 20 U.S. flag carriers and 67 foreign ones, giving the U.S. 23% of the total.
- In Fiscal 1950, U.S. carriers flew 818,000 passengers to and from the U.S. while foreign lines flew 277,000, giving the U.S. 74.7% of the total. In Fiscal 1960, U.S. carriers flew 2,505,000 passengers and foreign lines 2,071,000, giving the U.S. 54.7% of the total. (Traffic figures do not include U.S.-Canada transborder operations.)

The following chart shows the increases by area in traffic carried by U.S. lines. Note that international traffic more than doubled in the 10-year period between Fiscal 1950 and 1960. A private study and Senate hearings, scheduled to begin early next year, will be directed to the question of whether U.S. policies should be changed to help U.S. carriers win a larger share of the international market (AW Oct. 2, p. 37).

U. S. scheduled international carriers	Fiscal 1950 Atlantic	Pacific	Western Hemisphere	Total	Fiscal 1960 Atlantic	Pacific	Western Hemisphere	Total	Per Cent increase 1960 over 1950
Number	3	2	13	16[1]	3	4	15	20[1]	+ 25.0
Thousands of revenue passenger miles flown	859,842	328,160	914,624	2,102,626	3,014,765	1,733,593	2,938,222	7,686,580	+265.6
Thousands of revenue ton miles	122,463	55,177	125,362	303,002	454,612	267,926	375,015	1,097,553	+262.2
Unduplicated route miles	.....	.....	.....	103,107	.....	.....	.....	127,926	+ 24.0
Number of nations served	28	6	20	54	33	10	21	64	+ 13.5

[1] Total is not duplicated; therefore, it shows less than combined areas since Pan American World Airways flies to all three areas.

London Committees Oppose City Heliports

London—Housing and planning committees of four London councils have protested to the Ministry of Aviation against plans to build a city-center heliport in one of three Thames Estuary locations (AW Aug. 28, p. 57), primarily on the grounds of noise.

Westminster City Council has been asked to oppose by all means the construction of a heliport at Nine Elms Goods Yard, Battersea, because the helicopter noise level would be an intolerable nuisance.

As pointed out in the August report by a ministry committee on heliport planning, Nine Elms has 2,500 residents, four proposed schools and sensitive buildings (i.e., apartment houses). Westminster committee claims takeoffs would be on a 1:4 climb angle, with the helicopter flying 4,000 ft. before reaching 1,000-ft. flight altitude.

The Nine Elms heliport would be 1,070 ft. from Dolphin Square, London's largest block of private flats, and 790 ft. from Tachbrook Housing Estate. Residents from these two areas have been agitating against the proposed heliport since the ministry plans were revealed. Among other protests:

- **Stepney Borough Council** will be asked to oppose the St. Katherine's Dock heliport site, although this is the least desirable of the three, according to unofficial reports. Stepney Housing Committee claims construction would displace about 800 persons due to demolition of apartments now occupied.
- **Streets Committee** of the Court of Common Council has claimed construction of a heliport on the roof of the Cannon Street Station would make that section a living hell, if helicopters reached a peak period of a landing every two minutes.
- **Highways Committee** of Battersea Borough Council also has asked the council to object to a heliport at the Nine Elms site, due to noise.

Canada Sues Airlines Over Navigation Fees

Canadian government has filed suit against two transatlantic airlines that refused to pay a 400% rate increase it levied last year against users of air navigation aids and facilities operated by Canada.

Canada, which feels it should be reimbursed by airlines that use its radio facilities without landing at its airports, is seeking more than $700,000 from Pan American and KLM. Landing fees normally include charges of the type sought by Canada.

The claim against Pan American covers 7,445 transatlantic and 292 polar flights between Jan. 1, 1960, and Apr. 30, 1961. Suit against KLM cited 4,630 transatlantic and 272 polar flights during the same period.

Filed in Ottawa's Exchequer Court on Sept. 7, the suits were interpreted as test cases designed to answer whether Canada legally can quadruple international user charges. On Jan. 1, 1961, the Canadian government raised such charges from $20 per flight to $84 per flight. At least 10 U. S. and foreign carriers then served notice they would refuse to pay the additional $64.

BOAC, Air France and Lufthansa were among the carriers that agreed to pay the increase (AW Apr. 17, p. 45).

By international agreement, Canada operates the air traffic control system that covers the northwest sector of the Atlantic Ocean. It claims that the cost of keeping its Gander, Newfoundland, air traffic control center open exceeds $1 million annually.

Air France Order

Paris—Air France has ordered four Boeing 707-320B aircraft for 1963 delivery. The order will bring the carrier's Boeing fleet to 24 aircraft.

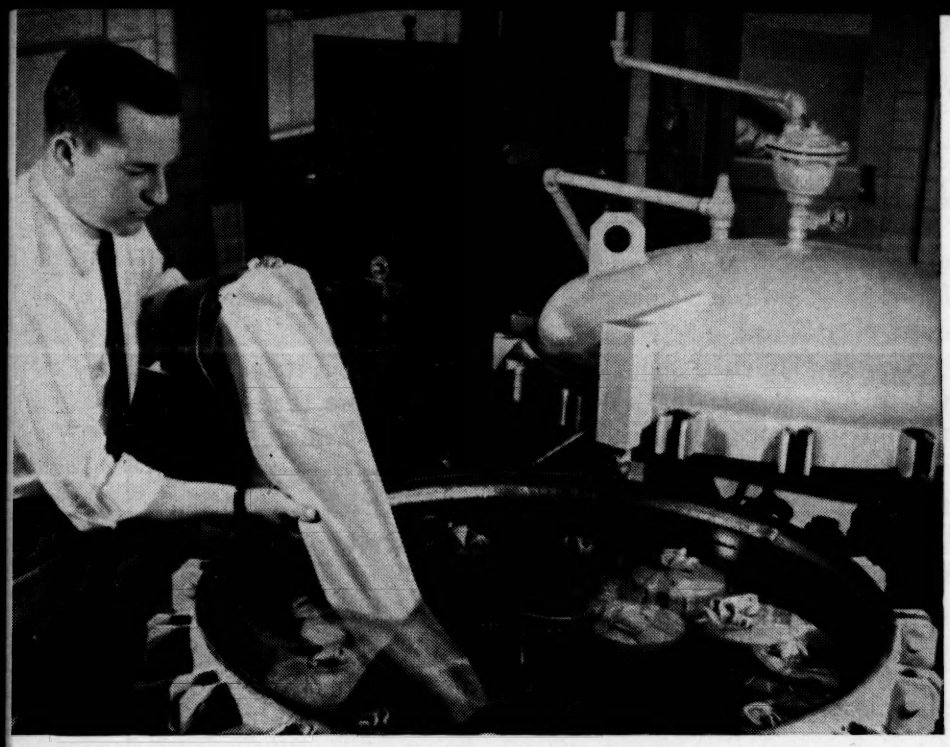
National Reports Loss Of Over $7 Million

Washington—National Airlines recorded a net loss of $7,254,145 on total operating revenues of $63,951,078 during Fiscal 1961.

Total revenues for the previous year were $68,642,866 with operating expenses of $74,763,052, as compared with $70,431,216 recorded during the past fiscal year.

Despite cuts of more than $4 million in expenses, National had a net operating loss of $6,480,138 in Fiscal 1961 as compared with a loss of $6,120,186 for the previous year. Net loss to the stockholders was calculated at $3.92 a share last year, as compared with a $1.57 loss in Fiscal 1960.

National attributed its losses to excess competition in the New York-Florida market; a general business recession; loss of the Cuban market; speed restrictions placed on its Lockheed Electra turboprop aircraft and "the unrealistic demands of labor resulting in two strikes during the fiscal year."



LOCKHEED JETSTAR—FIRST U. S. CORPORATE TURBOJET

Left: Shell engineer tests filter-separator at the AeroShell Turbine Fuel Equipment Laboratory—first in the U. S. **Right:** New Lockheed JetStar refuels. Shell sold over one billion gallons of aviation fuel last year.

Shell Research reports on 5 advances in fuels and lubricants and discloses how they improve aircraft performance

1. First non-ash additive oil for piston engine aircraft. AeroShell® Oil W is the first fully compounded additive oil ever *approved by every major piston engine manufacturer* in the U. S. AeroShell Oil W is the first piston engine oil that does not form harmful metallic-ash deposits.

It helps keep engines cleaner, extends periods between overhauls, can even lengthen engine life.

2. Shell grease lubricates X-15 as it sets world's speed record. Twenty-four greases were tested for use on the X-15 rocket plane. Only one —AeroShell Grease 5A®—passed all tests and was commercially available.

Today, AeroShell Grease 5A guards 23 vital control points in the X-15 as it sets new speed records for manned aircraft.

AeroShell Grease 5A is also recommended for commercial and private aircraft.

3. Full-scale gas turbine research lab. Shell Research built and operated one of the petroleum industry's earliest laboratories designed to investigate fuel performance in full-scale turbine engine combustion systems. This paid off in 1955 when the first airline introduced turbine aircraft. Shell was ready with the fuel.

Shell has the most extensive turbine fuel distribution network in the nation for general aviation and sold over a billion gallons of aviation fuel last year.

Today, Shell is the leading supplier of commercial aviation fuel in the U.S.

4. First turbine fuel equipment lab assures maximum cleanliness. Shell set up the first U.S. laboratory in the industry to study turbine fuel cleanliness. Its purpose: to assure Shell's ability to deliver uniformly clean fuel to your airplane.

As a result, today's Shell turbine fuel is of outstanding quality. You can buy it with absolute confidence.

Whatever plane you fly, wherever you fly it, Shell's experience in aircraft fuels and lubricants assures you of top performance.

5. Shell and fuels of the future. Shell has developed a special hydrocarbon fuel for Mach 3 flight. But the craft that will use it have yet to be perfected. When they are, Shell will be ready.

Shell rocket fuel—UMF®-C—is today powering the first-stage boosters of many of today's satellite vehicles.

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Shell's technical representatives are backed up with the solid experience and technical know-how that has made Shell the nation's top supplier of commercial aviation fuels.

Shell's advanced products and reputation with pilots assure that you will stay profitably ahead with a Shell dealership.

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SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are helping to provide better products for industry

Southern Impasse Prompts ALPA To Press Broader Picketing Rights

Washington—Airline labor problems multiplied last week as the Air Line Pilots Assn. began a drive to amend all existing contracts to permit members to picket any airline operating with alleged strikebreakers.

Immediate target of the union's program is solution of the 16-month-old Southern Airways strike, which ALPA estimates has cost the pilots' union $2 million.

Success of the drive would mean that ALPA pilots on several major trunklines could legally refuse to man flights destined for any point being picketed by the Southern pilots.

Major Strike Possible

Failure of airline managements to agree to such a provision could lead to a strike on all 47 airlines now holding agreements with the union, ALPA said.

ALPA President Clarence L. Sayen, admitting the gravity of such a large-scale shutdown, had said earlier the action would probably trigger formation of another presidential fact finding commission—a goal which ALPA has been seeking in the Southern dispute. Sayen, in apparent reference to the Feinsinger Commission appointed to investigate the nationwide airline shutdown by the Flight Engineers International Assn. last February, noted that such action has "worked for others."

However, ALPA members at Trans World Airlines, impatient over the delay in issuance of the final Feinsinger Commission report, threatened to walk-out after 14 months of fruitless negotiations (see p. 47). The commission has been working since February on recommendations to settle the long disputed "cockpit jurisdiction" issue between flight engineers and pilots.

Pilots' Case

The pilots have charged that while they are willing to accept the original recommendations made by the commission (AW May 29, p. 33) the company has refused to consider a contract settlement until the commission issues a final report.

Industry sources claim Feinsinger has completed a final report containing a more detailed resume of recommendations in the original report. It was reported that the final draft might be made public this week.

A dispute with navigators is complicating TWA's chances of settling with the pilots. TWA's 63 navigators, members of the air transport division of the Transport Workers Union, object to TWA's testing of dual doppler navigational systems. Earlier, they called off a strike after appointment of a special presidential emergency board.

The navigators contend that the system, to be operated by the copilot, will result in the eventual loss of their jobs. TWA pilots have noted that use of the system will increase their workload and can be expected to increase their wage demands if it is adopted.

Additional Provision

In the picketing clause drive, ALPA said it also wants to include a provision which would relieve pilots from carrying passengers who might produce revenue for struck carriers. If applied to the Southern situation, a spokesman said, pilots could refuse to transport any passengers transferring from or to a Southern flight.

The pilots of 19 airlines have already approved the plan, the union said; and most of the remaining airlines would be served with contract reopening requests "within a few weeks."

ALPA officials called the plan a means of restoring the "bargaining balance which the carriers are seeking to destroy through mutual aid pacts approved by the Civil Aeronautics Board, strike breaking subsidized by the Federal government and mutual subsidy through interline ticket arrangements."

Sayen said that other airlines were indirectly subsidizing Southern through interline agreements by which they provided Southern with 75% of its business. Last year, the union said, ALPA attempted to counteract this by having pilots refuse to cross Southern pilots' picket lines or fly into picketed airports. This plan, which would have affected a 13-state area, was blocked by a court injunction obtained by eight major airlines, the union said.

"In view of the Federal government's failure to prevent Federal subsidies being used for strike-breaking purposes, continued subsidization by other carriers through interline business, and the court's legal actions to prevent ALPA members from exercising their legal rights to observe picket lines of other members of the organization, it has become necessary for the pilots to invoke the procedures of the Railway Labor Act to clarify the right which they feel they now have of honoring the picket lines of their own brother pilots to protect themselves contractually," Sayen declared.

Newark Jet Additions

New York—Jet service to Newark Airport, where such equipment was barred until recently and now operates under restrictions, will be increased substantially Oct. 29 when TWA puts its first 707-120 into the airport and United adds Caravelle schedules.

TWA plans a daily one-stop service to Los Angeles and San Francisco via Baltimore. The airplane will take off light from Newark and add fuel at Baltimore, suffering no payload loss.

United, now operating three departures daily with the French jet, plans an increase to seven departures and arrivals.

American was granted permission to operate jets at Newark but has not scheduled them at the airport. American balked at the terms of the permission, which limited the airline to one daily schedule initially and described the jet operations as experimental, subject to cancellation.

Pyle Will Leave FAA For Industry Position

Washington—Deputy Federal Aviation Agency Administrator James T. Pyle, whose resignation was accepted by the White House last week, has been appointed vice president of General Precision, Inc., and will begin working with its office here on Dec. 1.

Administrator of the Civil Aeronautics Administration from 1956 to 1958, Pyle became FAA's first deputy administrator in 1959, serving under Elwood Quesada, the agency's first administrator.

Pyle, who is 47, will resign his FAA duties on Nov. 3. In a letter to the President, he said reasons of "a personal financial nature" forced him to leave the FAA post. His next employer, General Precision, Inc., is the principal operating subsidiary of General Precision Equipment Corp.

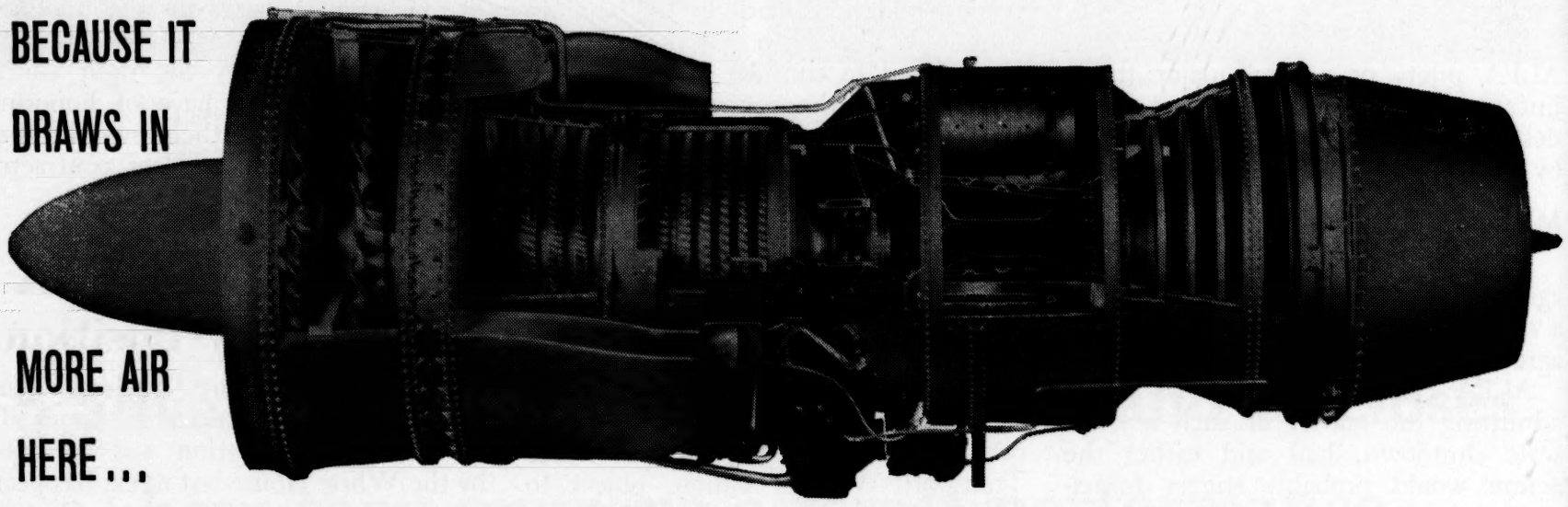
A 10,000-hr. pilot, Pyle was formerly a Pan American operations executive, president of Air Charter Co. of Denver, president of Denver Air Terminal Corp. and, in 1953, was appointed assistant to the Assistant Secretary of the Navy for air.

Navigation Aids Ordered

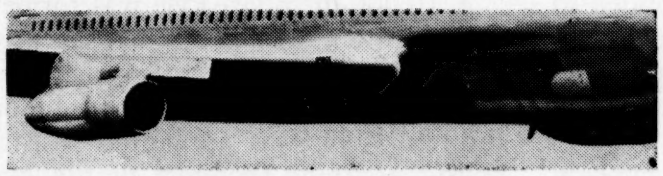
Washington—Seventy-one VOR radio ranges have been ordered by Federal Aviation Agency under a $2-million contract with the Televiso Corp. of Wheeling, Ill.

FAA will install 50 VORs for en route service, the remainder will be TVORs (Terminal VOR) which are installed at or near airports. Later this year FAA plans to convert the 50 en route aids to VORTAC installations, which will offer pilots distance and azimuth information. FAA hopes for delivery in one year.

BECAUSE IT DRAWS IN MORE AIR HERE...



THE PRATT & WHITNEY AIRCRAFT TF33 TURBOFAN GENERATES UP TO 42% GREATER THRUST



In simplest terms, this is how the Pratt & Whitney Aircraft TF33 (JT3D) turbofan has improved on the efficiency of the conventional turbojet engine. The TF33 is the logical extension of the turbojet's design simplicity, flexibility and unprecedented reliability, proved in over 15,000,000 hours of flight. The TF33's increased thrust—42% greater on take-off than its straight jet counterpart—permits use of shorter runways, gives quicker climb to cruise altitudes, and faster cruise speeds. Substantially reduced fuel consumption greatly extends range. Eight TF33 engines power the huge Boeing B52H. They develop 136,000 pounds total thrust, 40,000 pounds more than the B52G's turbojets—more power than any plane in the free world.

Pratt & Whitney Aircraft

Division of UNITED AIRCRAFT CORPORATION

EAST HARTFORD, CONNECTICUT

Stranded Charter Stirs Ire in Congress

Washington—Congressional critics of supplemental airline operations may utilize the recent stranding of 98 passengers by President Airlines for nearly a week in Shannon, Ireland, to trigger a full-scale investigation of supplemental airline operations and the Civil Aeronautics Board's control of them.

Staffs of both the Senate and House subcommittees on aviation are awaiting the completion of a CAB investigation of the incident, undertaken the day after a probe was requested by Rep. John Rousellot (R.-Calif.). He had criticized the management of the airline following the Sept. 10 crash of a President DC-6 at Shannon with the loss of 83 lives.

He also was highly critical of legislation, which could give supplementals a permanent operation authority, during House debate on the measure Sept. 18. Later, he criticized the way the Board is carrying out its responsibility to check the financial standing and safety precautions taken by the carriers.

Board spokesmen indicate that under present rules governing charter flights by supplementals, a detailed scrutiny of the airlines financial background is not required. Approval is granted on the basis of a formal application assuring that all CAB economic regulations have been complied with.

Several other carriers have also stranded charter passengers for various reasons, the spokesmen said, but investigations have determined that most of these incidents did not violate CAB regulations and were considered a contract breach between the airline and the charterer.

One notable exception, they said, was the case of Universal Airlines, which had its authority revoked nearly two years ago after the carrier collected funds for charters, but failed to make refunds after canceling the flights. The president of Universal then was George S. Patterson, who is currently the general manager of President Airlines.

Evidence uncovered in the investigation of President will be submitted with "appropriate recommendations" to the full, five-member CAB, spokesmen of the Board's enforcement division said.

Glenn H. Taylor, a Los Angeles builder who assumed control of President just two days after the Shannon crash, deplored the "unfortunate chain of events" and the unfavorable publicity which followed the accident, the stranding of passengers at Shannon, and a two-day delay encountered by 88 President charter passengers at London.

Taylor said he had talked with Rep. Rousellot and thought the congressman had cause for "legitimate concern" on his views of the supplemental industry, even though President was a "victim of circumstances."

Building public confidence in the supplemental industry as a safe and dependable mode of transportation will be one of the first phases of a major program now under way to make President the largest supplemental airline of its type, Taylor said.

The new president said he purchased the airline on Sept. 18 from Fred Wilson, of Sherman Oaks, Calif., after more than a year of negotiation. The carrier was created the year before by the transfer of an operating certificate formerly owned by California-Eastern Aviation, Inc. to the new firm with a capitalization of $100,000. Attorneys for President said that it was not necessary to make a legal filing of Taylor's purchase with CAB, since Taylor had no previous connection with the aviation industry.

CAB records listed Wilson as president, but Taylor said that Edward Ringo has now been named president under plans to revamp the entire management. Patterson has also been retained, Taylor said.

Taylor singles out the supplementals' "feast or famine" financial status, plus the timing of his acquisition of President Airlines as contributing factors to the six-day delay at Shannon.

Short of flight equipment because of the Sept. 10 crash, the airline faced the problem of returning 700 passengers from Europe with only a DC-6 and a DC-7 available, he said. The task was accomplished at a cost of $100,000 by ferrying the aircraft empty between New York and Europe. The DC-7 scheduled to pick up the Shannon passengers was delayed there for 48 hours for repairs.

When the repairs were completed, Taylor said, airport authorities and creditors refused to permit a takeoff until all bills were paid in cash. Checks had always been honored before, Taylor said. He admitted that paychecks of some President personnel in Ireland had failed to clear because of a transfer of company funds to a new bank. The transfer was made in conjunction with his acquisition of President, Taylor said.

An initial payment of $3,000 was forwarded to Shannon by a scheduled turbojet flight as soon as the delay was reported, Taylor said. When it became necessary to advance an additional $6,000, he pointed out, Shannon banks were closed for the weekend, delaying release of the flight even longer. Actual payment of the bills was made on the following Monday and the aircraft departed—six days late—the next day.

Taylor also criticized newspaper accounts of how President took care of the stranded Shannon passengers. Some elected to pay their way home on other airlines and a few stayed with relatives, but the majority was cared for by the airline, he said. Cost of these accommodations has not yet been determined by the airline, Taylor said.

The entire incident may have been averted if it had happened at a time when President could have obtained other aircraft, said Taylor, but none was available.

Taylor hopes to make President the largest supplemental airline and has purchased 34 Boeing Stratocruisers to provide a fleet capable of handling military contracts, Civil Reserve Air Fleet commitments and "world-wide charter operations at a price within the vacation budgets of medium- and low-income workers."

President expects to have five of the Stratocruisers in service within the next two months and has given a design engineering contract for modifications to Strato Engineering Corp. of Burbank, Calif. Formerly operated by Pan American World Airways and Northwest Airlines, the Stratocruisers will eventually be modified to incorporate swing tail loading for cargo, and later may be powered by turboprop engines, Taylor said. Negotiations for the modifications are currently being discussed with General Electric Corp., he added.

Taylor would not disclose the purchase price for the fleet, but said it was a "good deal" for President, and included a full inventory of spare parts.

Taylor said his purchase of President is a "life-long ambition." He said he intends to provide an unusually generous retirement plan for the airline's pilots and is prepared to use much of his Taylor Building and Development assets to further his plans on President.

Cargo Helicopters

Moscow—Aeroflot plans to make unprecedented use of helicopters for cargo flights between the Black Sea coastal resort of Adler and nearby Caucasus Mountain villages this fall.

During the summer, Adler-based Mi-4s averaged more than 20 tourist flights daily to other resorts along the coast and in the mountains. Now some of these craft are shifting over to transportation of machinery, equipment, medicines and processed foods to agricultural villages in the mountains. Return loads are fresh fruits and vegetables.

Some isolated mountain points which are a two or three day drive from Adler during the fall and winter can be reached in 15 minutes by helicopter.

To thread a needle in unmanned flight...

required Motorola systems ingenuity

NAVIGATION with "needle's eye" precision is achieved by Motorola RDI. Synergistic combinations of Radio, Doppler, and Inertial sensory data into one integrated system exceed the sum of the capabilities of each. Ranging hundreds of miles from their ground-anchored reference, these R+D, R+I and R+D+I combinations provide targeting accuracy... immunity to interference... resistance to detection. Unique combinations of these techniques have been proven in applications requiring real-time, position-fixing and space vehicle-guidance. These Motorola systems originally were designed for missile guidance and surveillance drone navigation... they now provide reliable solutions to a broad range of problems requiring continuous, current, and extremely accurate control data never before attained in a dynamic environment. Sensory synergism is another demonstration of Motorola's systems ingenuity. Classified details of these programs are available to those with an established need to know.

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SHORTLINES

▶ **Air Line Pilots Assn.** plans to set a strike deadline at Trans World Airlines soon. ALPA told the National Mediation Board that the company has "procrastinated and refused" to deal with their problems on grounds that they were waiting for more reports from the Feinsinger Commission.

▶ **American Airlines** reports its passengers may now order a rental car, along with hotel or motel accommodations, when they make travel reservations.

▶ **Braniff Airways** will add one new nonstop Boeing 707 flight from Dallas to Chicago and another to New York on Oct. 29, making a total of three jet flights daily to both cities from Dallas.

▶ **Bureau of Customs** has adopted a simplified procedure for handling baggage of foreigners traveling through the U. S. en route to another country. This baggage no longer must be inspected by Customs officials as long as it remains in the airline's custody and passengers have no access to it.

▶ **Delta, National,** Northeast, Trans World and United airlines have combined their 1961-62 winter package vacation listings for Florida and the Caribbean area into a single handbook for the convenience of travel agents.

▶ **Eastern Air Lines,** only trunkline refusing to employ youth fares, has now changed its position and "reluctantly" filed for youth fares effective Oct. 22.

▶ **Iberia Air Lines** will take delivery on its first Caravelle jet transport in January. The aircraft will be used on Iberia's European and African routes.

▶ **International Air Transport Assn.** has published the proceedings of its Symposium on Supersonic Air Transport held last April in Montreal. The 215-page summary costs $2.50 and the volume of working reports prepared from 1,200 pages, is $10. Order from IATA, Montreal 3, Canada.

▶ **Western Air Lines** has bought three Boeing 720Bs, bringing its Boeing jet fleet to nine. The new aircraft, to cost about $15 million, will be delivered next July and August.

▶ **Youth fares** evaluation and statistical reports may now be filed up to 30 days after each successive three-month period, instead of 10 days. Civil Aeronautics Board made the change after considering a request by National Airlines.

AIRLINE OBSERVER

▶ Recent bilateral talks with Italy ended in a stalemate with the Italians threatening to restrict the number of U. S. flights into Rome unless granted a new route from the West Coast, and the State Department refusing to comply. Meanwhile, there has been speculation that several foreign governments might attempt to resurrect an old plan to define the entire European area as "cabotage" territory to be served only by European carriers. However, fears of smaller nations that this could cost them their lucrative operations into the U. S. were considered sufficient to defeat any such move.

▶ **Eastern Air Lines has registered the term "Air Bus" with the U. S. Patent Office and now has exclusive right to its use. The airline is also seeking to register the term "Air Shuttle."**

▶ Aeroflot officials seem touchy about repeated queries on development of a Russian supersonic transport. Questioned by a Moscow news reporter on the Soviet Union's civil aviation "prospects," Aeroflot Deputy Chief Georgi Schetchikov declared: "I know what you are getting at. Most of all you want to know when the supersonic passenger planes will appear. Well, the designers are busy on them, so be prepared . . ." In another Russian publication, Schetchikov reported that Aeroflot carried 20% more passengers westbound on the trans-Siberian, Khabarovsk-Moscow route last summer than handled by the Siberian railroad between the same points. Observers cite this as evidence of progress toward Russia's goal of carrying all long-haul passengers by air, and cargo by rail.

▶ **Air Line Pilots Assn. executive committee has urged union pilots flying into airports served by Southern Airways to exercise unusual caution because, ALPA contends, strike-breaking pilots hired by the carrier are incompetent (AW July 17, p. 49). Local ALPA councils are to urge their members to file and not cancel instrument flight rule (IFR) flight plans even if the weather is clear. Extreme conservatism in planning approaches and in taxiing also was recommended by the union's top committee. These measures were interpreted as a move to exert pressure on Southern through other airlines by complicating airport operations.**

▶ Watch for Riddle Airlines to announce the purchase of 10 additional Douglas DC-7s from Scandinavian Airlines System, thus bringing the Miami-based carrier's fleet to 20. Douglas and Lockheed Aircraft Service are competing for the order to convert some of the aircraft to DC-7CF configuration. However, Riddle reportedly plans to use several of the new DC-7s to carry passengers only.

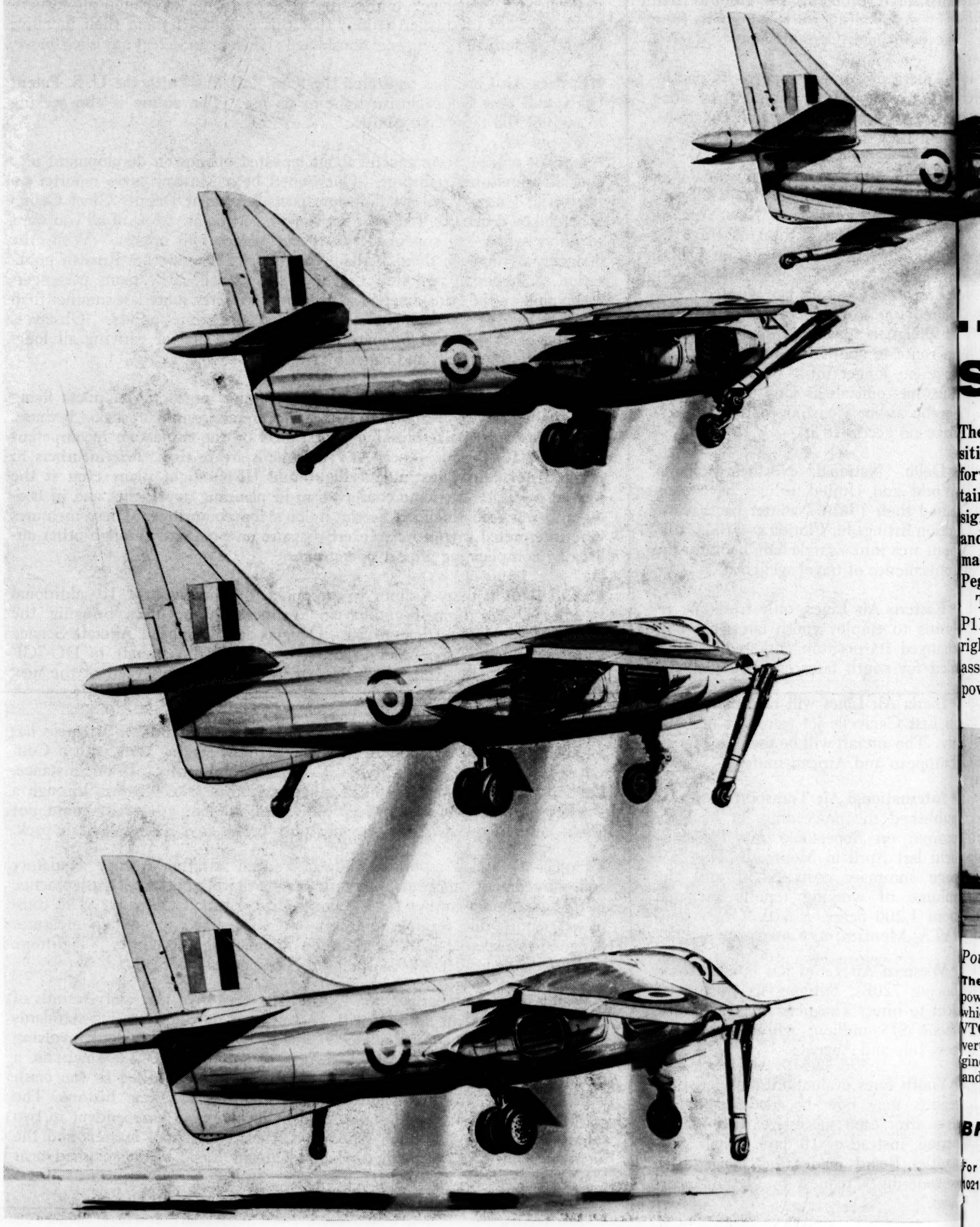
▶ **Pronounced retarding effect of slush on jet transport takeoff distances has astonished Federal Aviation Agency officials now staging tests with a Convair 880 at FAA's Atlantic City, N. J., experimental center. In one instance, the 880 was accelerated to 100 kt., then steered at takeoff power through a strip of pulverized ice 1 in. deep and 3,000 ft. long. Aircraft could not attain rotation speed of 124 kt. until just before it cleared the slush pack.**

▶ Project Tightrope report, a study of Federal Aviation Agency regulatory and enforcement procedures, promises to be sharply critical of past practice in this area under former FAA Administrator Elwood Quesada. The completed report, due for release this week, is expected to contain measures designed to expedite FAA hearing and rule-making procedures. Tightrope task force was headed by Washington Attorney Lloyd Cutler.

▶ **Watch for British parliamentary furor this week over the safety records of Britain's independent airlines, with an emphasis on pilot training standards and flight equipment maintenance. Catalyst is the latest accident involving an independent, Derby Aviation, owners of a Douglas DC-3 which hit a mountain in the Pyrenees Oct. 7. All 34 aboard were killed in the crash which recorded the first fatalities in the company's 20-year history. The Derby crash was the second major accident involving an independent in two months. Thirty-four London schoolboys, their two school masters and the flight crew of three were killed when a Cunard Eagle Viking crashed near Stavangar, Norway, in August.**

BAS

Revolutionary VTOL aircra



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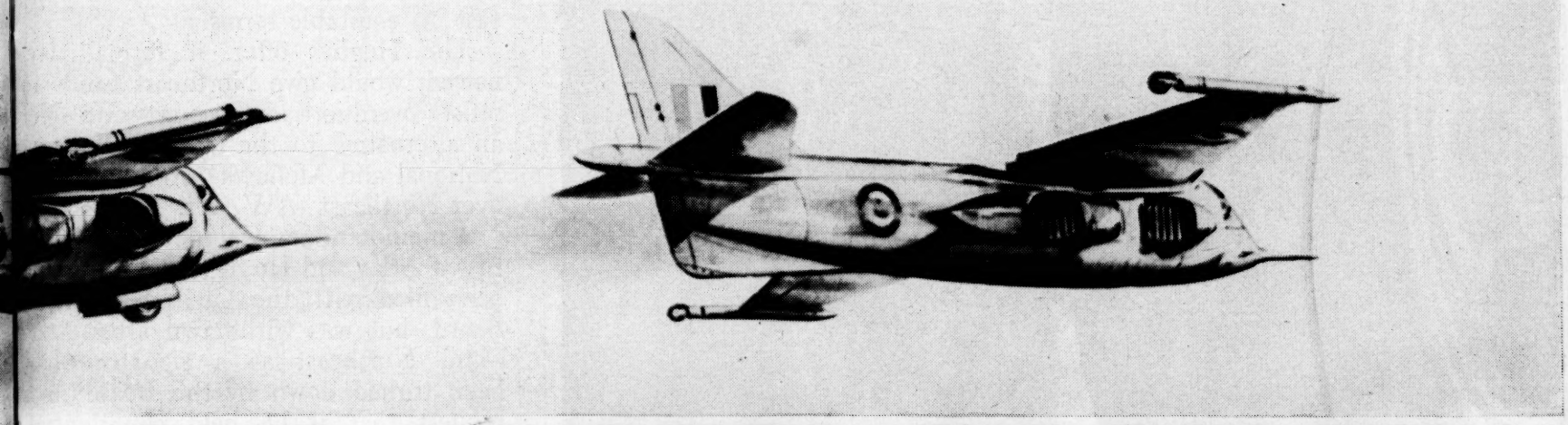


...AND BRISTOL SIDDELEY SUPPLY THE POWER

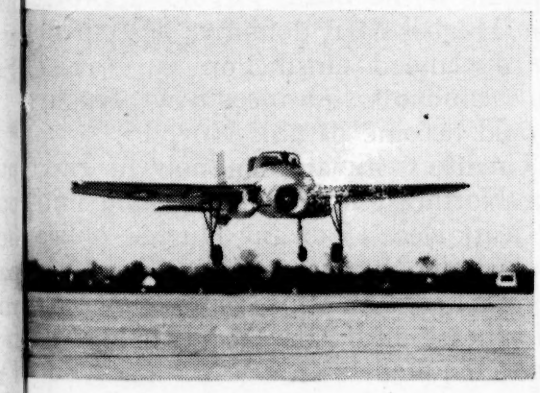
The Hawker P1127 strike aircraft has made its first transitions—from vertical take-off to forward flight and from forward flight to vertical land. The world's first jet-sustained VTOL (vertical take-off and land) aircraft to be designed for operational service, the P1127 obtains both lift and thrust from the same engine. The engine that has made this historic advance possible is the Bristol Siddeley Pegasus turbofan.

These successful transitions—coming so early in the P1127 flight-test program—are eloquent testimony to the rightness of the Bristol Siddeley VTOL philosophy, which asserts that the total installed thrust of an aircraft's main powerplant must be available for vertical take-off and landing, hovering as well as for forward flight.

The Bristol Siddeley Pegasus has four controllable jet nozzles which can be directed downwards for lift, backwards for thrust or in any other direction required. This unique feature makes possible the design of single- or multi-engined subsonic or supersonic aircraft in which total installed thrust is available for vertical take-off and for transition between vertical and horizontal flight.

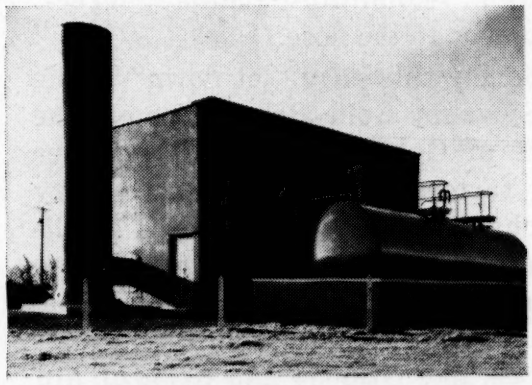
Where ground conditions permit, a Pegasus-engined aircraft can make a short take-off for a heavier load or a conventional take-off if a large overload is required.

The Bristol Siddeley Pegasus is supported by the Mutual Weapons Development Program for NATO.



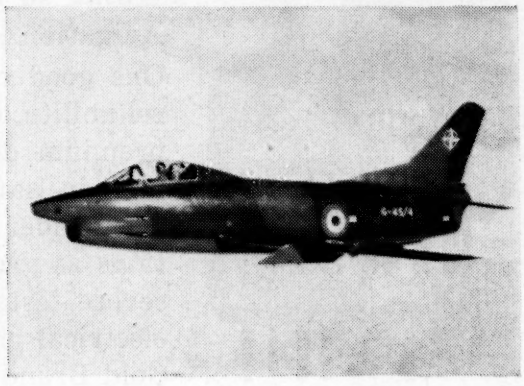
Power for this

The Bristol Siddeley Viper turbojet powered the Bell X 14 research aircraft, which was the world's first jet-sustained VTOL aircraft to achieve transition from vertical to horizontal flight. The Viper engines range from 1,600- to 3,000-lb. thrust and power many different aircraft.



... and this

The Bristol Siddeley Industrial Proteus gas turbine powers a 3,000 kw. turbo-generator. Designed for peak-lopping and emergency stand-by generation, these new pocket power stations, two of which are now in service, deliver full power within 2 minutes of a cold start for a low capital outlay.



... and this

The Bristol Siddeley Orpheus medium-thrust turbojet powers the NATO standard lightweight strike fighter—the Fiat G 91. The Orpheus has been selected for 5 different aircraft types which are in production, and is flying in India, France, Japan, Italy, Finland and Britain.

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Hughes, Atlas Extend Northeast Discussions

Negotiations were continuing last week between Atlas Corp. and Howard Hughes over a Hughes offer to provide Northeast Airlines with much-needed cash and working capital on condition that Hughes Tool Co. could acquire the Atlas controlling interest in Northeast on equitable terms.

The Hughes offer, if formally renewed, would give Northeast funds to satisfy overdue trade accounts and offer an alternative to the offer of Eastern, National and Mohawk Airlines to take over Northeast (AW Oct. 2, p. 41).

A memorandum of understanding between Atlas and Hughes Tool Co. had been filed with the Civil Aeronautics Board, but was withdrawn after Atlas —and Northeast as a signatory—had been turned down by the Board in a request that it be held confidential.

The memorandum was then made public by Raymond M. Holliday, Hughes Tool vice president, with the comment that Hughes Tool had not requested any confidential treatment by the Board.

Reason given for its withdrawal was that the memorandum carried a cut-off date of Sept. 30 for execution of definitive agreements between Hughes and Atlas, and since this date had passed new terms were necessary.

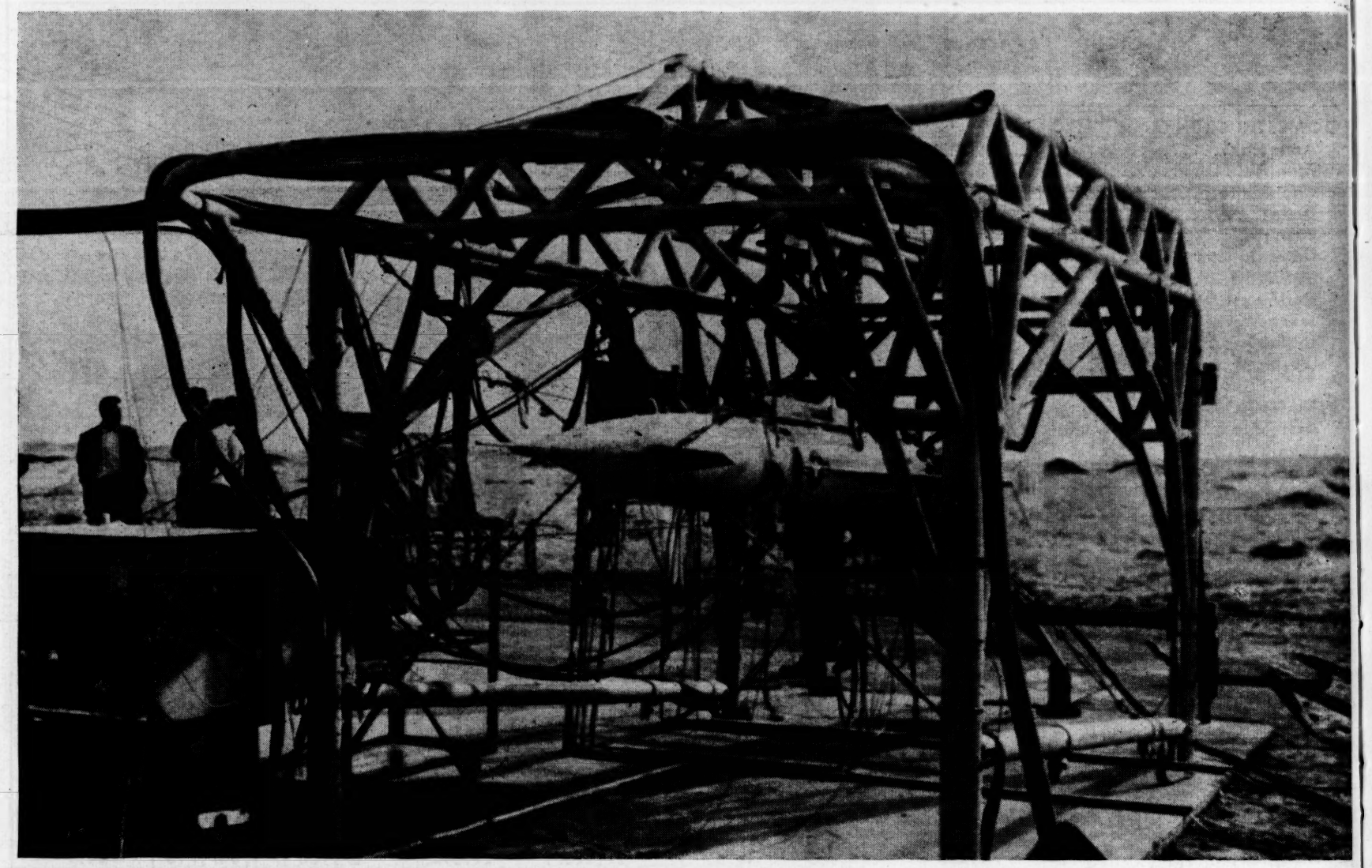
Key points of the Hughes offer:

- **CAB approval,** as well as that of other necessary government agencies, is required.
- **Advances of $5 million** would be made to Northeast by Hughes when the memorandum became effective, except that not more than $1 million would be provided prior to CAB approval. If the Board had not approved the Hughes-Atlas definitive agreements or disclaimed jurisdiction by Nov. 1, any amounts advanced by Hughes would become payable Nov. 15.
- **Creditors' moratorium** now in effect for Northeast must be continued until at least Dec. 15 or any Hughes obligation under the memorandum would be terminated. In this same provision, Northeast and Atlas also would have been required to arrange for a schedule of payments for principal and interest deferred under the moratorium.
- **Continuity of management** would be sought by Hughes, including a commitment to offer James W. Austin, Northeast president, a three-year contract at his present annual salary.
- **Payment to Atlas** would be acceptable in any combination at Hughes' discretion of cash, Hughes Tool notes, shares of common stock of Atlas (Hughes owns 11% of Atlas), or TWA debentures, with or without the attached warrants for purchase of TWA stock.

Airline Traffic—July, 1961

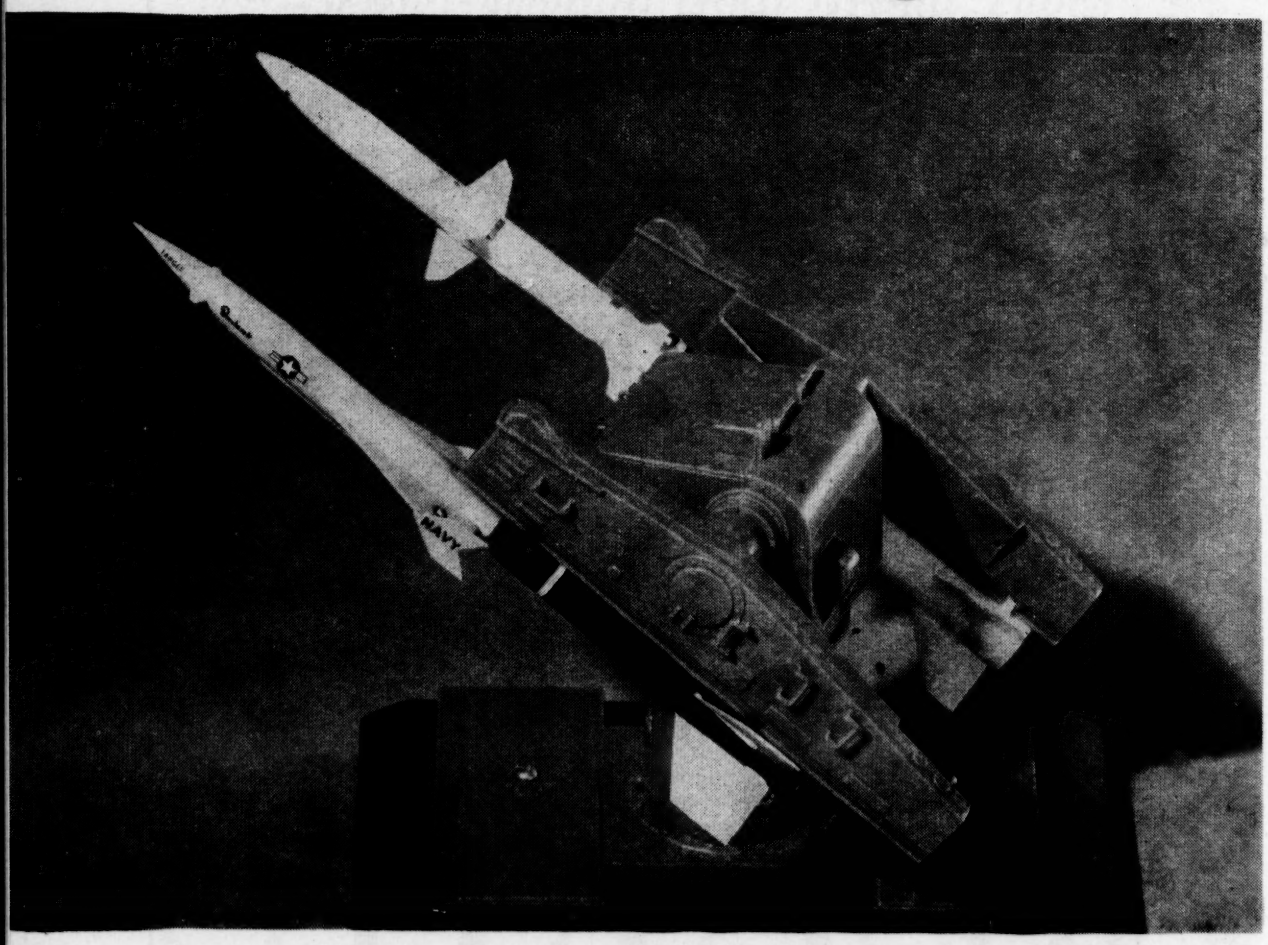
	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Load Factor %
DOMESTIC TRUNKS								
American	618,084	517,443	62.0	1,695,480	839,398	9,168,404	61,238,318	52.4
Braniff	173,292	84,474	54.1	344,206	164,875	826,206	9,429,060	43.2
Continental	113,631	82,717	44.3	219,832	113,401	526,807	8,790,046	44.3
Delta	280,583	175,048	55.4	578,027	326,377	1,587,578	19,283,470	46.9
Eastern	648,077	341,324	50.9	1,138,294	465,126	2,046,968	36,862,092	40.3
National	150,559	115,456	55.0	394,365	67,144	856,732	12,430,124	41.1
Northeast	154,343	68,172	48.8	144,067	48,195	233,174	6,954,011	40.4
Northwest	149,029	111,637	54.4	543,084	225,960	999,523	12,446,399	47.1
Trans World	401,499	402,986	58.2	1,394,335	675,073	4,767,511	45,451,978	46.6
United	994,468	678,997	55.8	3,728,467	1,247,498	7,650,215	77,592,617	48.7
Western	141,994	88,800	56.6	282,247	82,978	333,888	9,199,355	44.4
INTERNATIONAL								
American	7,664	8,851	59.7	6,008	906	314,875	1,236,615	51.2
Braniff	9,604	13,275	56.8	54,745	.....	171,329	1,613,672	48.0
Caribbean Atlantic	40,891	2,895	72.2	1,932	.....	11,350	284,581	70.7
Delta	1,874	2,497	46.7	609	.....	13,078	277,719	43.7
Eastern	57,374	83,314	74.3	120,244	.....	446,332	8,365,757	67.8
Mackey	12,561	2,182	49.0	.....	198	6,696	221,630	48.7
Northwest	24,658	43,140	55.4	1,467,806	10,606	701,855	6,750,484	60.0
Pan American								
Alaska	8,010	8,680	50.4	43,702	3,346	242,464	1,193,476	47.1
Atlantic	196,380	336,379	60.2	2,658,793	.....	5,390,737	42,434,597	52.8
Latin America	140,421	189,299	73.2	519,959	.....	4,342,614	24,535,174	70.9
Pacific	48,445	183,989	70.6	3,188,223	12,408	3,782,653	25,895,182	61.4
Panagra	11,443	20,764	64.8	98,063	.....	716,174	3,034,489	61.2
South Pacific	319	875	53.2	593	.....	1,172	91,481	46.3
Trans Caribbean	17,059	26,463	89.1	.....	.....	133,606	2,359,269	88.6
Trans World	36,407	120,872	50.5	1,384,646	.....	1,859,862	15,615,737	47.1
United	23,516	58,637	63.7	327,537	11,277	192,091	6,490,227	52.4
Western	5,618	8,777	56.3	11,274	.....	35,509	947,998	46.3
LOCAL SERVICE								
Allegheny	72,208	14,985	41.4	21,225	29,592	67,156	1,547,713	44.1
Bonanza	25,562	6,362	44.0	7,222	2,432	10,913	631,183	44.8
Central	21,374	4,052	34.2	11,925	6,225	21,775	428,299	32.5
Frontier	31,182	8,511	37.1	25,966	11,028	68,744	929,904	39.9
Lake Central	34,856	5,611	32.2	9,604	21,263	15,247	582,329	32.9
Mohawk	58,384	12,513	41.7	20,190	23,929	31,865	1,269,898	39.9
North Central	95,150	18,402	45.1	44,209	52,002	61,093	1,905,505	45.9
Ozark	44,990	8,127	41.9	18,312	27,214	33,318	866,183	46.4
Pacific	36,691	8,187	45.7	14,825	4,210	10,677	810,474	46.1
Piedmont	44,145	9,610	46.6	13,485	16,657	21,583	972,690	47.8
Southern	32,558	5,894	32.6	25,785	14,069	24,777	629,140	34.6
Trans-Texas	26,295	6,060	33.4	18,507	9,589	40,584	648,127	34.1
West Coast	32,848	6,160	44.2	14,611	6,210	28,590	828,711	44.9
HAWAIIAN LINES								
Aloha	42,430	6,871	68.0	2,594	.....	5,426	558,338	57.2
Hawaiian	55,546	8,871	64.8	3,706	.....	155,117	871,316	62.6
CARGO LINES								
Aerovias Sud Americana	.....	.....	.....	.....	.....	238,616	238,616	70.1
Flying Tiger	9,836	41,495	80.5	16,190	16,622	8,317,567	12,499,895	77.9
Riddle[1]	9,301	45,866	92.1	32,521	19,414	5,867,014	10,495,351	74.7
Seaboard World	10,908	42,521	100.0	411,105	.....	3,244,214	8,318,531	83.9
Slick	1,459	9,557	93.7	.....	.....	5,471,689	6,416,178	87.8
HELICOPTER LINES								
Chicago Helicopter	20,011	353	41.7	1,906	.....	.....	35,615	35.7
Los Angeles Airways	4,612	163	58.4	4,366	2,135	.....	22,051	63.8
New York Airways	12,625	226	50.0	863	599	555	23,644	46.5
ALASKA LINES								
Alaska Airlines	5,436	3,970	32.6	48,341	1,890	482,474	947,976	51.6
Alaska Coastal	7,518	721	62.0	3,504	.....	6,280	82,700	64.8
Cordova	3,653	648	62.2	4,168	.....	40,854	110,595	60.9
Ellis	6,593	418	53.7	1,897	.....	3,354	47,372	60.8
Kodiak	1,394	96	33.8	532	.....	1,028	11,392	39.0
Northern Consolidated	4,955	1,580	52.7	46,113	.....	78,937	296,121	64.4
Pacific Northern	14,818	14,403	60.3	138,652	8,289	447,367	2,151,295	71.9
Reeve Aleutian	1,676	1,484	46.6	52,051	.....	104,237	319,237	62.1
Western Alaska	1,745	68	72.0	791	.....	2,556	9,804	58.0
Wien Alaska	7,625	2,792	68.1	54,893	.....	151,725	489,402	59.3
Avalon	14,727	562	54.4	852	.....	1,121[2]	55,393	56.4

[1] Riddle's figures show combined domestic and international operations.
[2] Includes excess baggage.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.



TEST FIRING of the XKD2B-1 Rocketdyne storable liquid-propellant rocket motor was conducted at Point Mugu, Calif., with the test vehicle fastened to stand. Instrumentation pickup lines are attached for data collection.

Beech Missile Target Nears Service Tests



MARK 10 TERRIER LAUNCHER for destroyers and cruisers could be adapted to fire the KD2B-1. Terrier also could be launched simultaneously to simplify tracking exercises. Target and missile shown are not to same scale.

Wichita, Kan.—Beech Aircraft Corp.'s high- and low-altitude supersonic missile target is nearing completion of contractor flight trials and between October and December will begin a series of demonstrations to U.S. Navy and U.S. Air Force, which are potential customers for the vehicle.

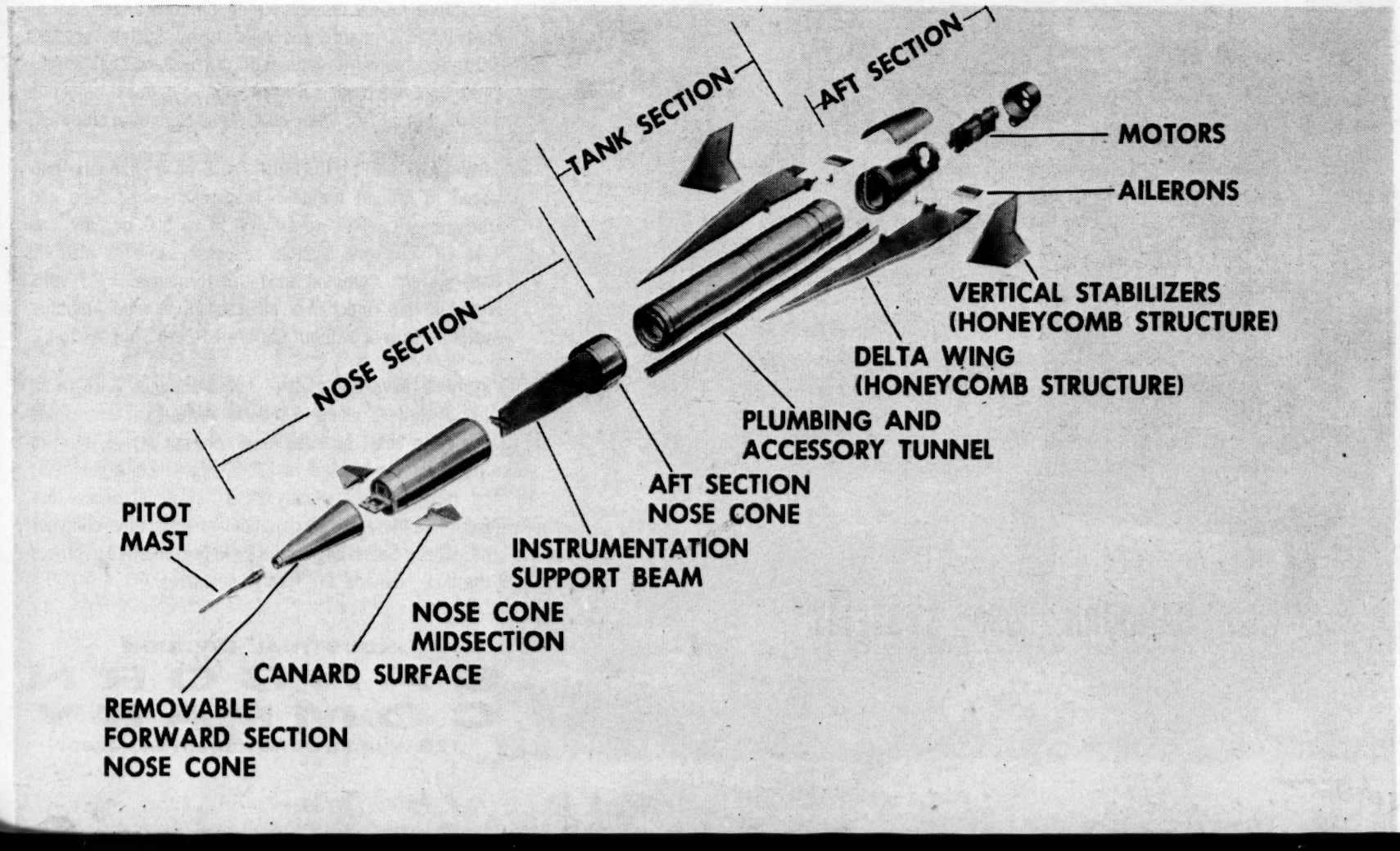
The manufacturer expects that Navy will be able to start formal service evaluation of the new target early next year. Known to the Navy as the XKD2B-1 and to the USAF as the XQ-12, the liquid-rocket-powered vehicle already has been tested up through Mach 1.6 at 35,000-40,000 ft. and is expected to achieve its designed Mach 2 performance soon.

Current Plans

Current plans call for the first 16 drones to be powered by a North American Aviation Rocketdyne XLR-64-NA-2 storable liquid-rocket engine and follow-on vehicles are to have the NAA XLR-64-NA-4 powerplant which features variable orifices for modifying the thrust.

Prime feature of the target system is its adaptability to use by land, sea and

SHARPLY SWEPT DELTA WING planform of XKD2B-1 Mach 2 target is shown in rear-view of full scale mockup. External nozzle beneath two rocket motor nozzles is infrared augmenter. Below, exploded drawing shows easily accessible nose which carries scoring system, autopilot, programmer, radar augmentation and other equipment.



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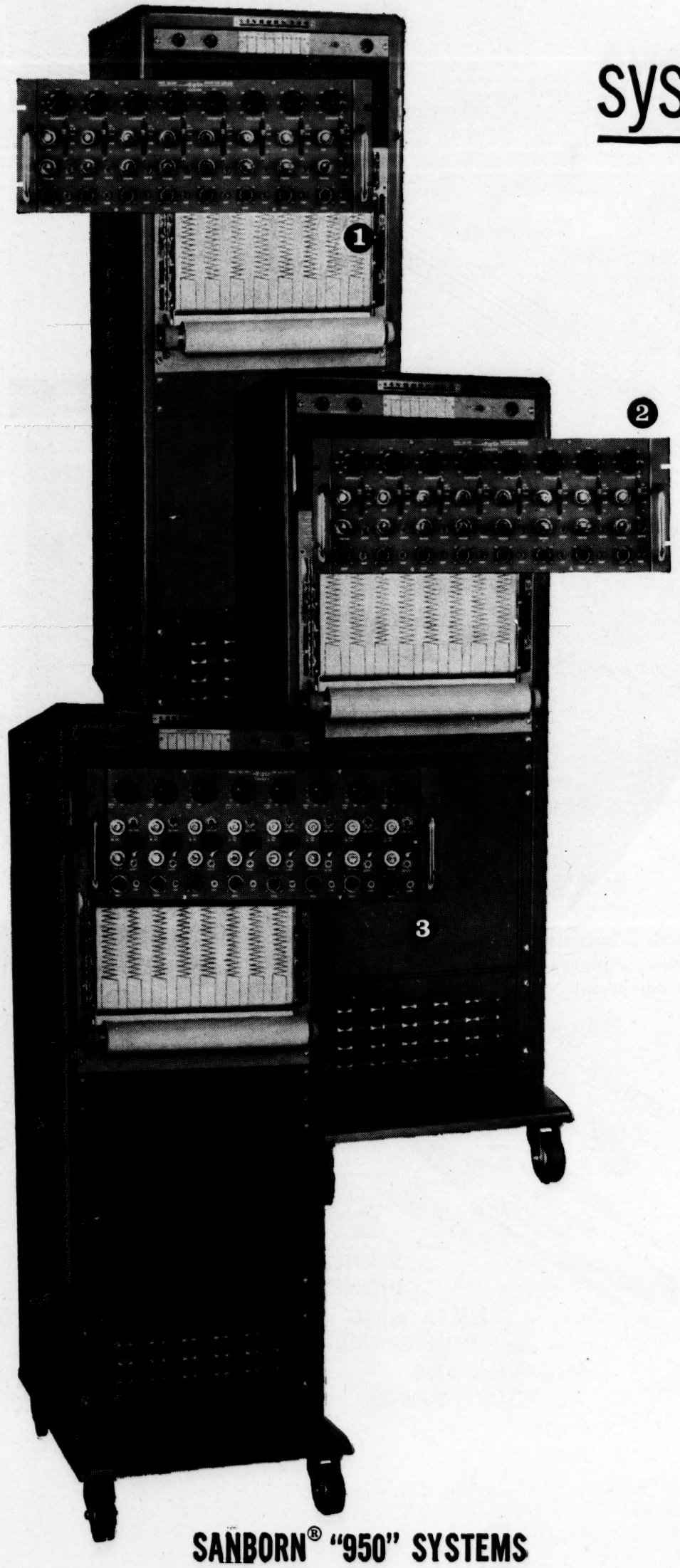

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2 MEDIUM GAIN AMPLIFICATION . . . 6 or 8 transistorized channels with floating and guarded inputs; ½ meg. resistance on mv ranges, 1 meg. on volt ranges; sensitivity 0.5 to 20 mv/div and volts/10 div. System response DC to 150 cps within 3 db at 10 div peak-to-peak amplitude. Common mode voltage ±500 volts, max., rejection 140 db min. at DC. Same controls as High Gain amplifier.

3 LOW GAIN AMPLIFICATION . . . 6 or 8 channels, balanced to ground inputs 5 meg. each side; tube and transistor circuitry; sensitivity 10 to 500 mv/div and 1 to 10 volts/div. System response same as Medium Gain system. Common mode performance ±2.5 volts and 34 db min. rejection on most sensitive range. Amplifier available with or without Calibrated Zero Suppression.

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air services, Beech notes. It is designed for launching from the Navy's McDonnell F3H (initial trials at Pt. Mugu have been carried out using this type) and the F4H, Grumman F11F, North American FJ-4 and Douglas A4D and F4D; also from the USAF McDonnell F-101, Convair F-102 and F-106 and Martin B-57E. Consideration has also been given to enabling the drone to be launched from land and ship-based Terrier and Talos missile launchers, with ability to fit both target and missile to the same launcher to simplify fleet operational practice. For ground-based training, the vehicle can also be lofted from a special Beech-designed mobile launcher or it may be adapted to firing from Nike-Ajax launchers.

If testing is carried out on schedule, the new target is expected to enter military inventories in 1962.

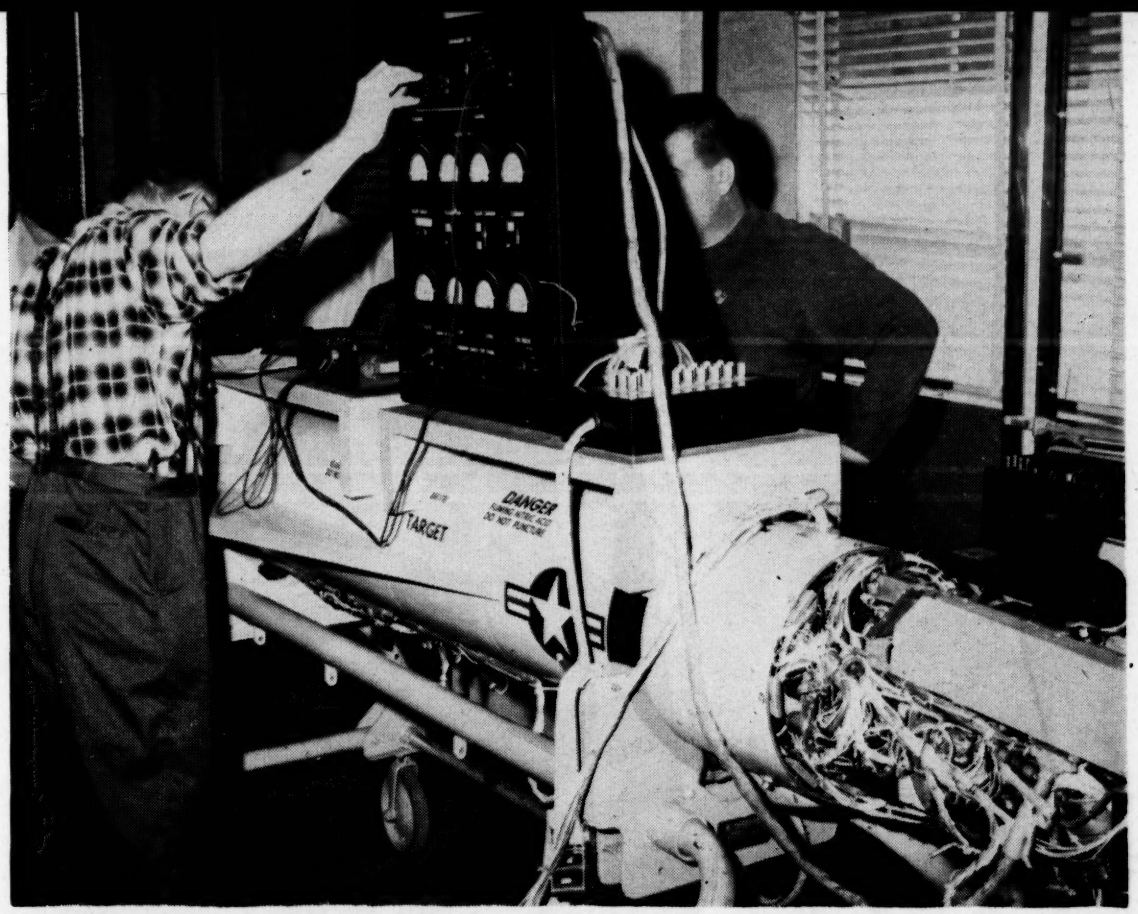
Measuring 13 ft. 5 in. over-all length with fuselage diameter of 13 in. and wingspan of 3 ft. 3 in., the XKD2B-1/-XQ-12 has a gross weight of 560 lb. It has a payload capacity of up to 2,000 cu. in., permitting up to 47.5 lb. of special equipment to be carried depending upon the mission.

Construction is basically of aluminum, with sharply swept delta wings, vertical stabilizers and avionic equipment shelves being of honeycomb makeup. Wings have a magnesium carry-through structure. Fuel and oxidizer tanks—a section approximately six feet long—are made of stainless steel. Fuel, MA F-4 Hydyne, a hydrazine-base formula, and the inhibited red fuming nitric acid oxidizer, with nitrogen pressurant, are supplied to dual thrust chambers.

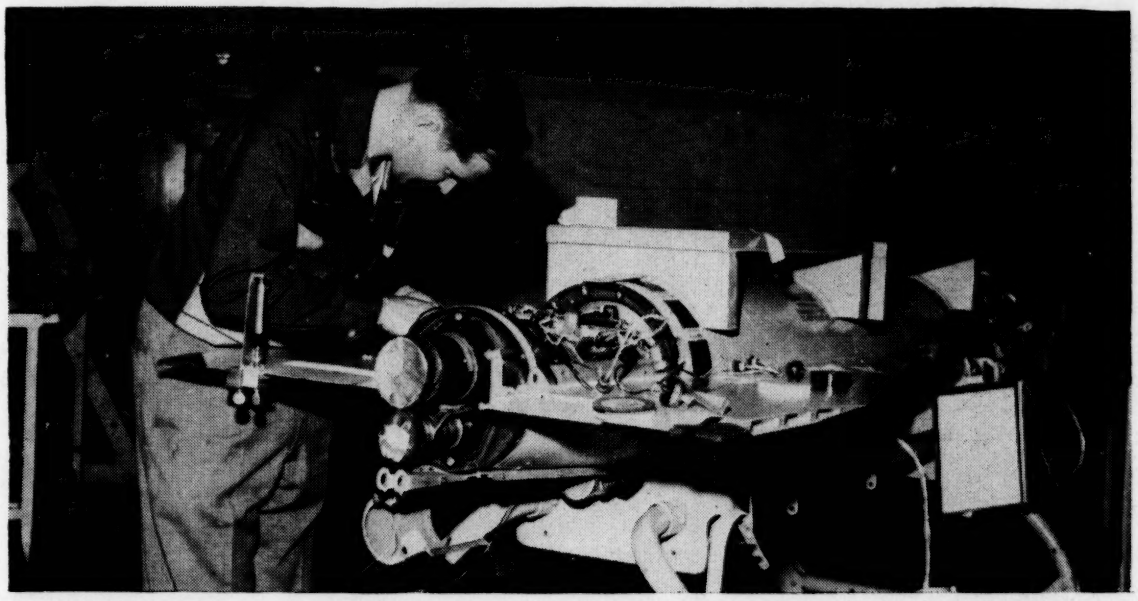
Both types of Rocketdyne motors consist of a booster and sustainer thrust chamber, capable of being started and stopped from sea level to 100,000 ft. Both types of motors (NA-2 and NA-4) provide a maximum thrust of 5 min. and a minimum of 8.5 min. for the sustainer phase and 1.5 min. maximum thrust and four minutes minimum thrust for the booster.

Basic difference between the two engines is that the later NA-4 incorporates a "dry propellant line," whereby lines between fuel tank and fuel-start valves are kept free of propellant during storage and handling, and has a dial system for thrust selection, providing four different orifice combinations for each thrust chamber and a total of 16 thrust combinations for each tank pressure setting. The NA-2 engine measures 18.5 in. long, 5 in. wide and 9 in. high and has a dry weight of 16.7 lb. The NA-4 rocket measures 21 in. long, has the same width and height dimensions as the NA-2 and weighs 22 lb. dry.

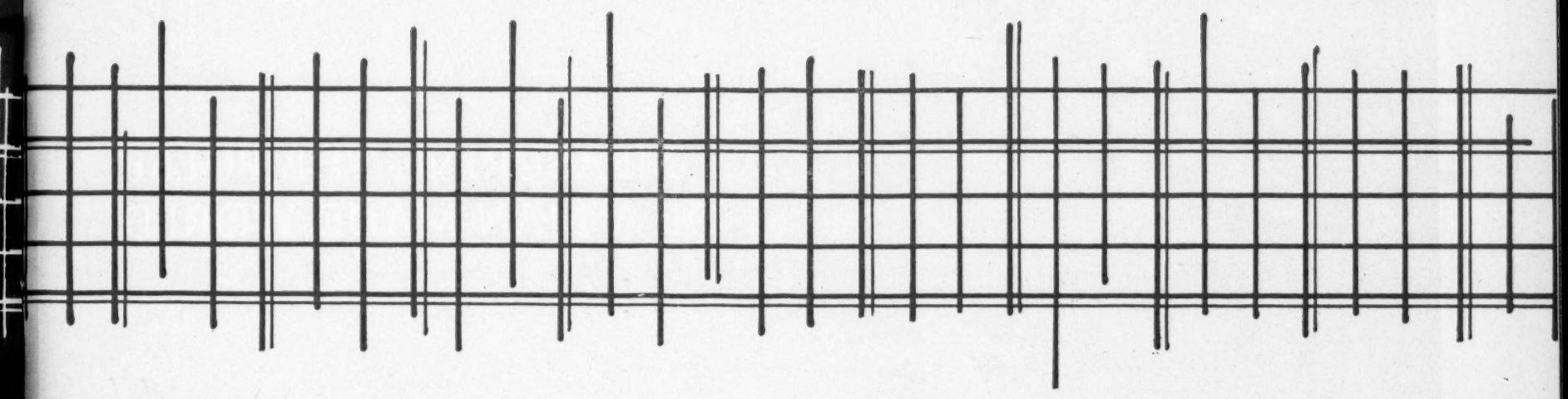
Aside from the thrust varying capability of the NA-4, the two engines pro-



ELECTRONIC EQUIPMENT gets checkout at Pt. Mugu, using calibration gear that sets atop platforms that cradle on the target's back for convenient handling.



TARGET'S ROCKET ENGINES, above, are easily accessible. **Below,** crewmen fuel target at Pt. Mugu, where contract flight program was conducted.



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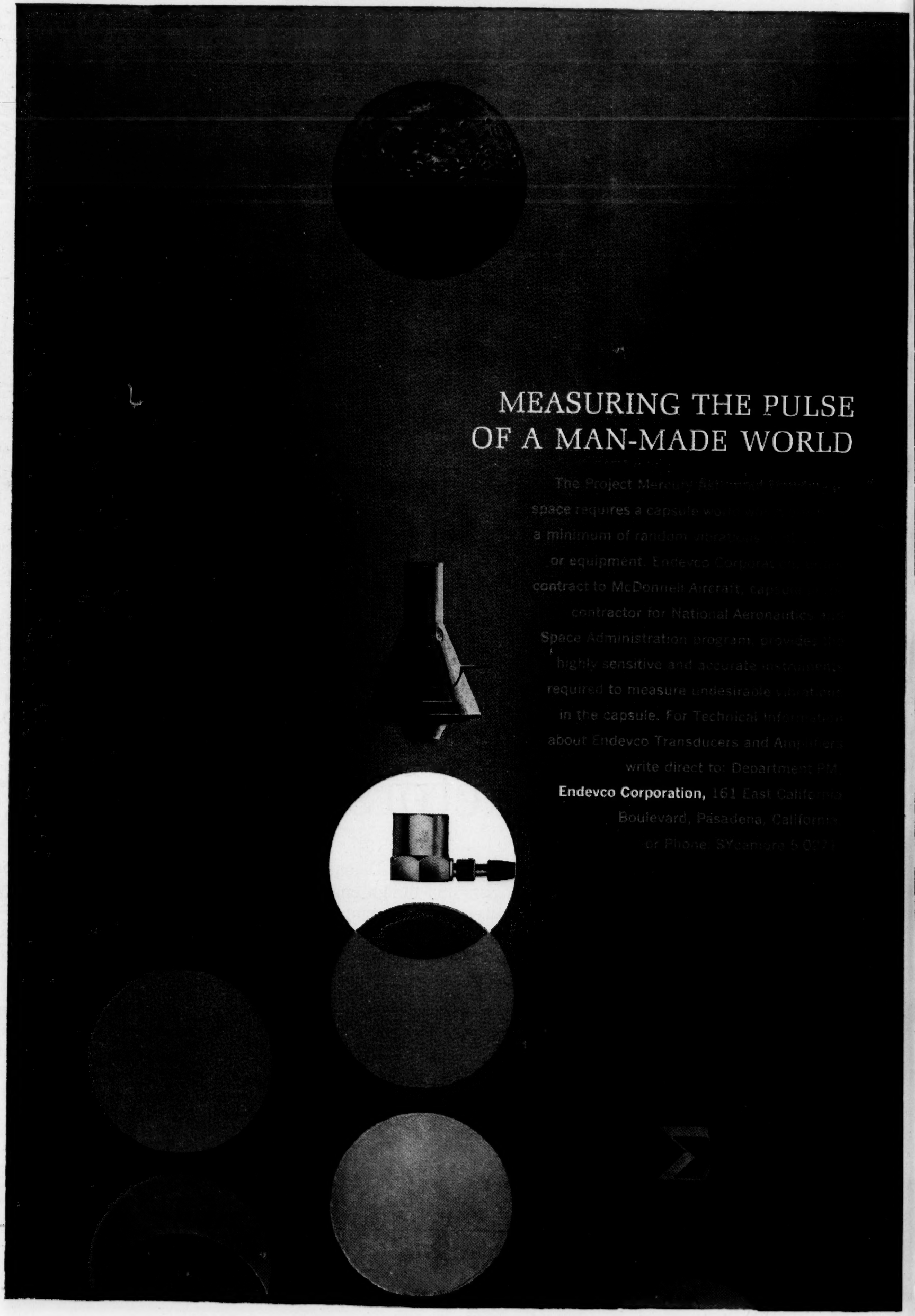
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vide similar performance characteristics. The booster stage has a thrust range of 220-685 lb. at 35,000 ft., with nominal thrust at this altitude being 550 lb. and nominal specific impulse at the same height of 231 sec. The sustainer phase provides a thrust range of 85-130 lb. at 70,000 ft., a nominal thrust of 106 lb. at this altitude and specific impulse of 262 sec. at that height.

This provides the XKD2B-1/XQ-12 with a performance ranging from Mach 1.2 and endurance of 75 sec. at 5,000 ft. to Mach 2 and endurance of 5 min. at 70,000 ft. Actually, taking glide period into account, the vehicle is estimated as having a useful tracking duration of some 27 min.

Guidance system is a Beech-designed inertial type providing pre-programing so that the vehicle seeks preset altitudes and speeds. A radio link is provided for destruct purposes, command range being 250 mi.

Beech has also designed a simple go, no-go type checkout console for sequence testing the target subsystems prior to installation in the vehicle. Utilizing 28 v.d.c. power, the console provides complete checkout in 10 min. and is designed for operation following simple instruction in its use. Stowage and handling of the target system utilizes simple basic equipment: a cradle adapter makes possible use of standard Navy and USAF bomb dollies for mobility in shop, ramp or ship deck areas and the company has also designed a roadable general purpose trailer capable of carrying two complete targets over normal roads as well as unimproved terrain.

Nitrogen Conversion and Storage Unit Installed for Industrial Use

Orlando, Fla.—A 6,000-psi. nitrogen conversion and storage system—believed to be the first ever installed for industrial use—is in operation at the Martin Co.'s Orlando Division.

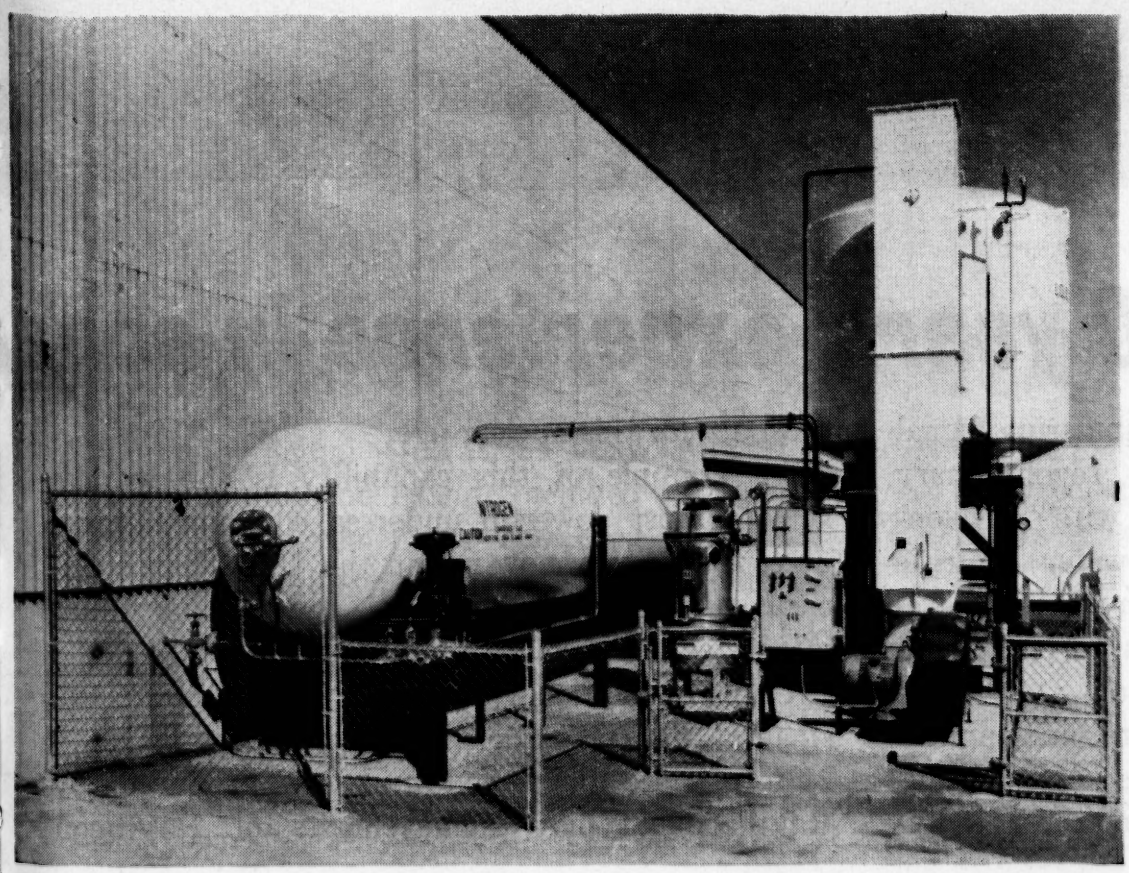
System was designed and built by Gas Engineering and Development Department of Air Reduction Co., Inc. (Airco), New York. Previous similar systems have operated at only about 2,400 psi.

Airco installed the system adjacent to the Orlando plant to meet Martin's requirements for high purity nitrogen at pressures up to 5,000 psi. in manufacture and test of missile components and other equipment.

Low-pressure liquid nitrogen is delivered by trailer and pumped into a liquid storage tank with a capacity of 265,000 standard cubic feet nitrogen gas equivalent. Liquid nitrogen is then piped to a reciprocating pump with 6,000-psi. maximum discharge pressure.

It then passes through an ambient air heated vaporizer for conversion to gas and into another storage vessel with 250,000 standard cubic feet capacity at 6,000 psi.

Gas storage tank is 5 ft. in diameter, 5¼ in. thick and more than 46 ft. long, designed to provide required volume needed to satisfy peak flows above pump capacity. The tank is connected



NITROGEN conversion and storage system built by Airco is in service at Martin-Orlando.

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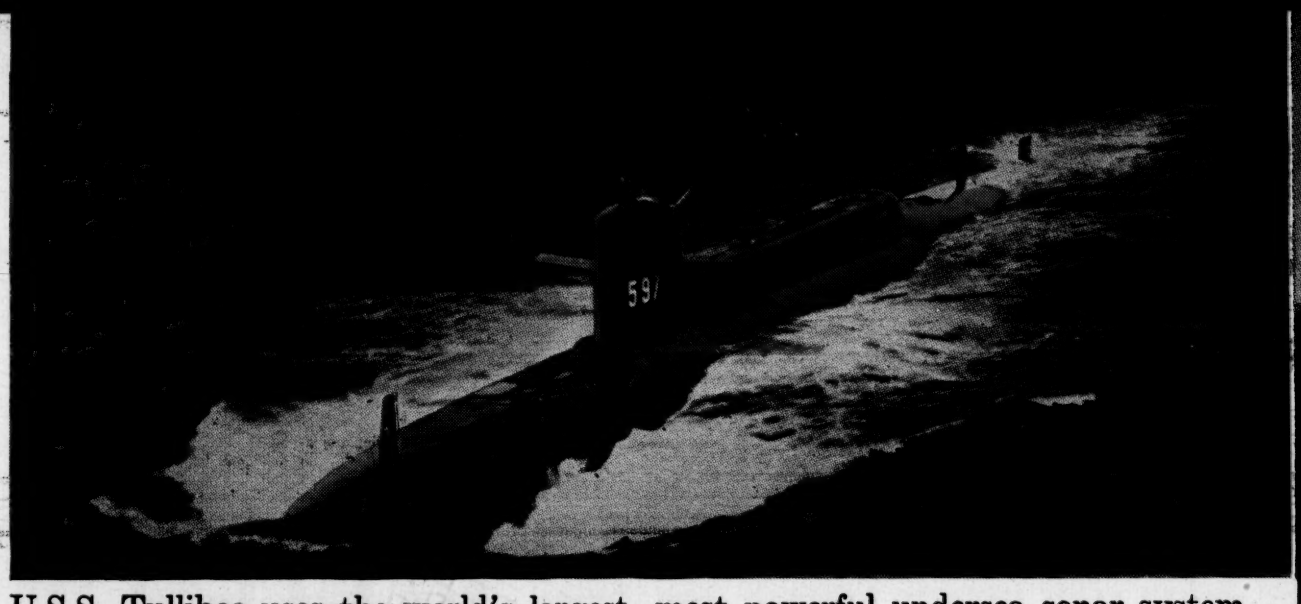
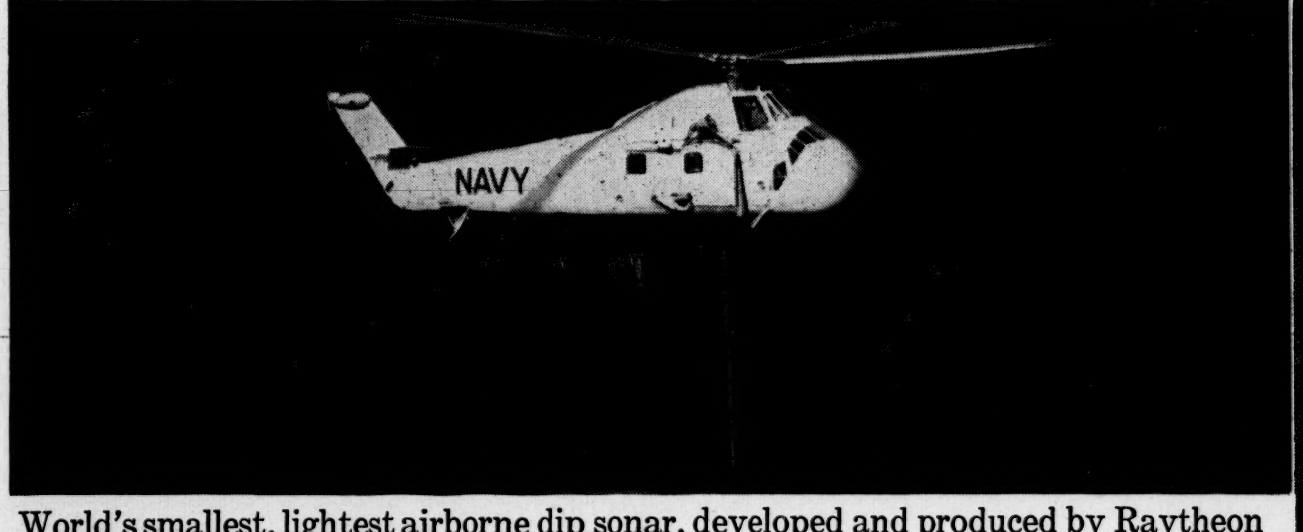


U.S.S. Tullibee uses the world's largest, most powerful undersea sonar system, developed and now being produced by Raytheon.



World's smallest, lightest airborne dip sonar, developed and produced by Raytheon for U.S. Navy's A.S.W. operations.

Raytheon surface sonars are in world-wide service with the navies of the Free World.

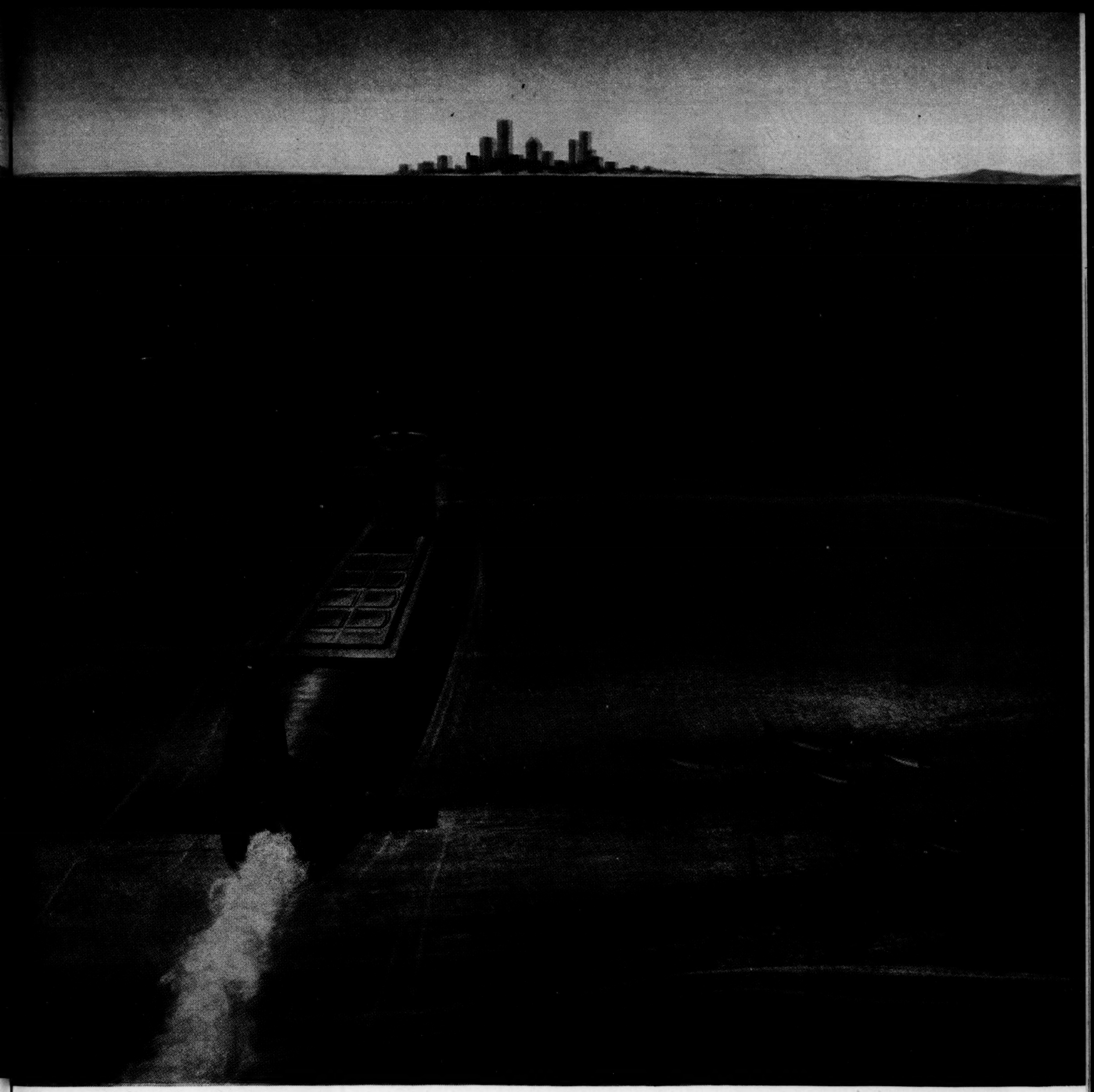
Raytheon's 60 years' experience in sonar

For over 60 years Raytheon's Submarine Signal Operation has led in advancing revolutionary hydrosonic concepts — beginning with development of the world's first underwater acoustic navigation equipment in 1901. From advanced systems to hydrophones, transducers, drivers, and amplifier components, Raytheon is today one of the United States Navy's chief developers and suppliers of airborne, surface and underwater ASW equipments that help meet the ever-growing threat in hydrospace for this nuclear age.

An example of this capability is the world's largest, most powerful undersea communications-detection system, now within the U.S. Navy's nuclear submarine Thresher. It is the first fully hull-integrated ASW sonar.

Under evaluation by the U.S. Navy is the world's smallest, lightest airborne dipped sonar.

Both were developed and are produced by Raytheon — typical achievements of Raytheon



helps meet the threat in hydrospace

Submarine Signal Operations ASW Center at Portsmouth, Rhode Island. Included among other significant achievements are advanced, fully transistorized sonar units for surface vessels of the Free World's Navies.

A unique defense complex, Submarine Signal Operation's ASW Center is the nation's first completely integrated industrial facility devoted exclusively to the design, development and production of Anti-Submarine Warfare equipment and systems. Its capability is further augmented by scientific and technical support from Raytheon's 34 plants and laboratories coast to coast.

FOR BROCHURE of Submarine Signal Operation's capabilities, write: Raytheon Company, Department 68, Lexington 73, Massachusetts, Attention: M. B. Curran.

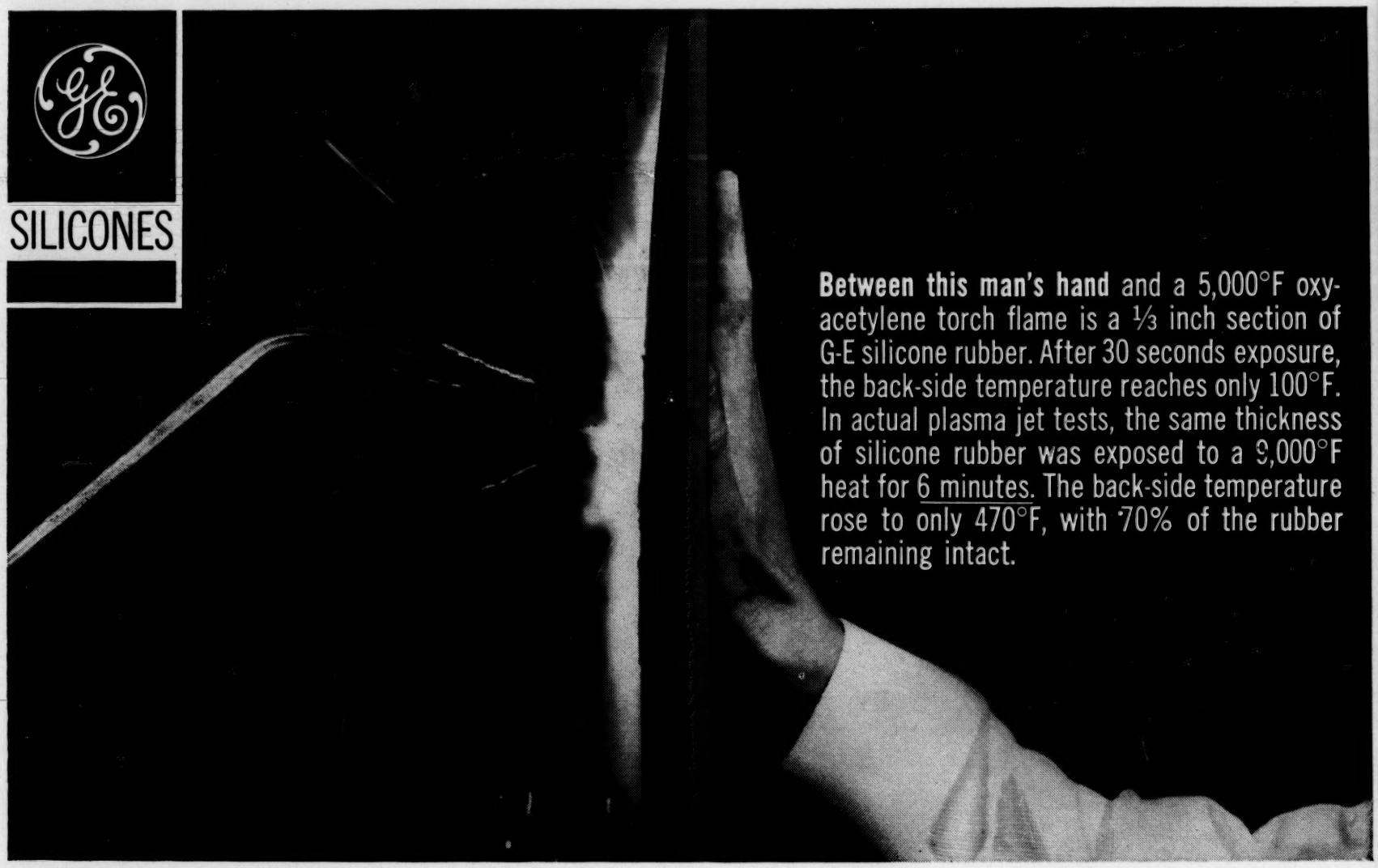
FOR EMPLOYMENT OPPORTUNITIES, write: P. Alexander, Raytheon ASW Center, Box 360, Newport, Rhode Island.

RAYTHEON COMPANY

EQUIPMENT DIVISION

RAYTHEON

SILICONES



Between this man's hand and a 5,000°F oxy-acetylene torch flame is a ⅓ inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

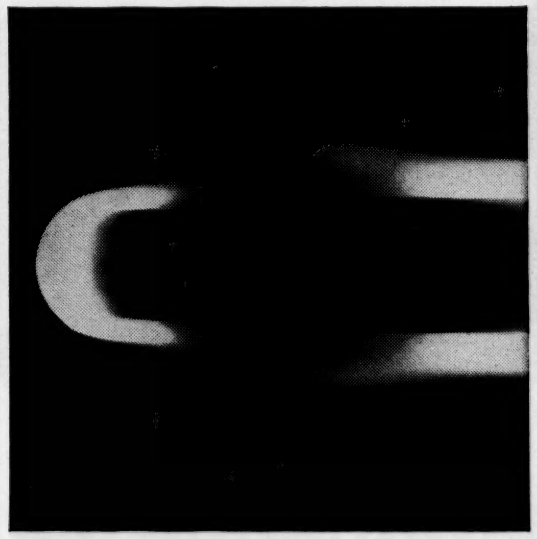
Thermal barrier against 5000°F flame

GENERAL ELECTRIC SILICONE RUBBER

RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation
Vel. = 17,000 ft./sec.
Alt. = 250,000 ft.

Exposure time at 9,000°F	Back-side temperature of ⅓ inch section of G-E silicone rubber
30 seconds	100°F
2 minutes	210°F
3 minutes	300°F
4 minutes	375°F
5 minutes	430°F
6 minutes	470°F



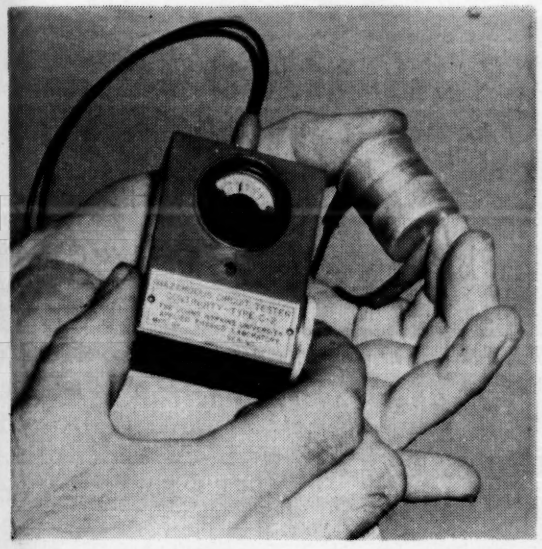
The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from —150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.

Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section J1061, Waterford, New York.

GENERAL ELECTRIC



Missile Circuit Tester

Hazardous circuit tester, for continuity checks of explosive bolts and other one-shot devices, provides extremely small electric current which is below firing threshold of most sensitive explosive charges. Device, developed by Applied Physics Laboratory, The Johns Hopkins University, can measure resistances from 0.1 to 10,000 ohms. Electric current for continuity test comes from silicon photocell which is illuminated by tiny lamp powered from separate battery, both sealed in plastic to assure electric isolation. Tester is used to check out Polaris missiles, but has application to other missiles.

to piping extending throughout the main Orlando plant where line pressure is automatically maintained at 5,000 psi.

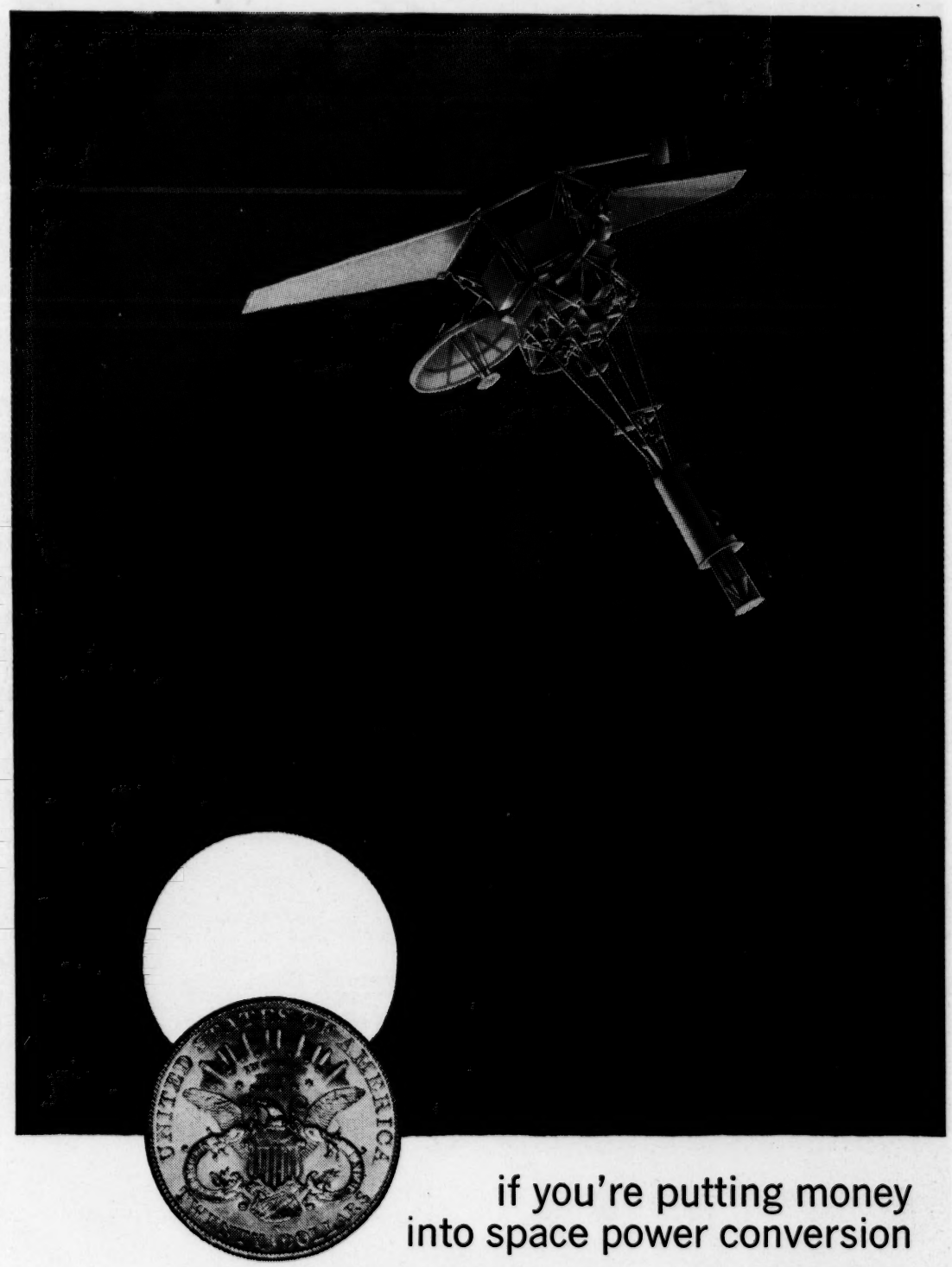
Hydrocarbon content of the gaseous nitrogen is monitored by a non-dispersive continuous infrared analyzer to check contamination level. The analyzer monitors gas in ranges from 0 to 0.2 parts per million of hexane by volume. Sample pressure is 1,500 psi. Moisture content is monitored by a highly sensitive electrolytic detector.

Airco 125-7-A liquid nitrogen customer station has been installed at Martin's Inertial Guidance and Microwave Laboratory in Orlando. The station automatically provides high purity nitrogen at 150 psi. for use in checking missile guidance systems.

Skybolt Powered Flights Expected by End of 1961

Powered flight tests of the Douglas Skybolt air-launched ballistic missile are likely to begin at USAF Eglin Gulf Test Range, Fla., by the end of this year, if the record of highly successful air drops made thus far continues.

Separation drops were successful following a minor modification introducing spoilers that provided positive clean breakaway of the missile from the B-52G testbed pylon and a further drop checking out Skybolt systems will be made soon prior to powered flight.



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50 MILLIONTHS

The rotor of Sperry's new Mark 1 Mod. 2 gyro spins on a cushion of hydrogen, with clearances of only 50 millionths of an inch between it and the journal. The gas bearing, replacing the ball bearing of earlier models, reduces both production time and cost—and at the same time provides 300 to 400 percent higher accuracy for the Sperry Mark III SINS (Ship's Inertial Navigation System) designed for Navy's Polaris subs.

This big bonus in accuracy will be of vital importance to the Polaris missile; the entire system accuracy derives from it. And the accuracy must be there not for the few minutes it takes to put a missile on its trajectory, but for the days, weeks and months it is poised for action in the submarine beneath the sea. Actual Navy tests of production units of the Mark 1 Mod. 2 have shown it to surpass today's gyro standards many times over. With slight modifications to present inertial systems, these second generation gyros can replace their predecessors for added navigational accuracies.

SPERRY

MARINE DIVISION, SPERRY GYROSCOPE COMPANY • DIVISION OF SPERRY RAND CORPORATION, SYOSSET, N. Y.

Rotary Motor Tested as Booster Control

By George Alexander

Indianapolis—Solid propellant motors, fitted with right-angle nozzles and rotating about their longitudinal axes, are being advanced by Allison Division of General Motors Corp. as a complete and independent thrust vector and attitude control system for boosters.

Allison, with an eye on the upcoming Saturn and Nova booster programs, says the system would increase over-all propulsion efficiency and reliability by eliminating such potential problem areas as flexible joints, seals, nozzle actuators, jetevators and other control devices now used in swiveled and gimbal-mounted engines. Thrust of the rotary motors, the company says, would be sufficient to compensate for their weight, which would be greater than conventional thrust vector control (TVC) systems.

Direction of Rotation

The motors are rotated around their longitudinal axis, the least moment of inertia.

According to Allison, this approach minimizes the actuator forces required for rotation and also makes it easier to install the motors on other propulsion units.

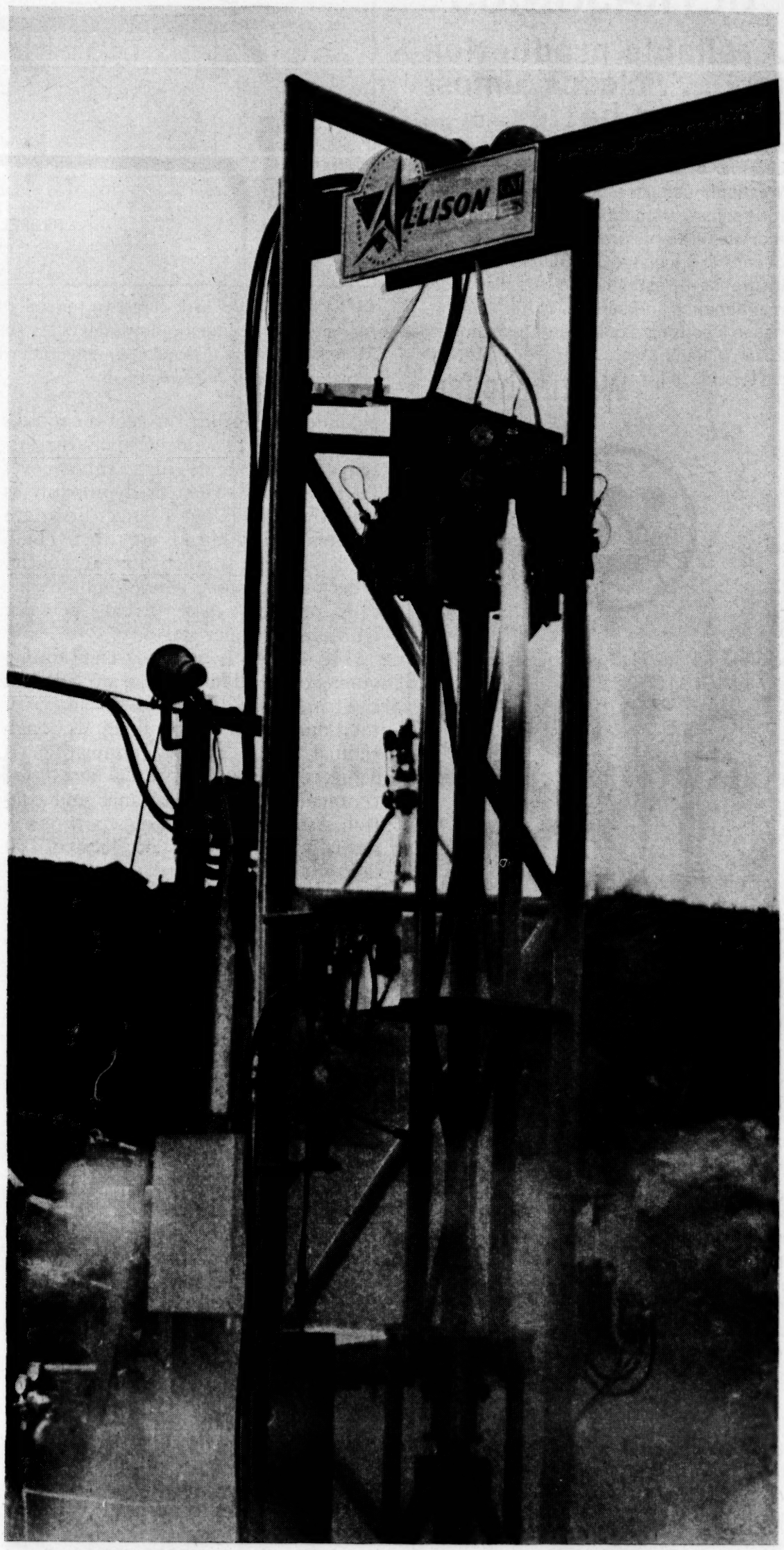
The company offers two actuation subsystems, electrical and hydraulic, the former using a motor to translate signals from the guidance and control system for a conventional gear-drive mechanism and the latter—also standard—being recommended for motors above 11,000 lb. thrust.

Response Rate

Response rate of the actuator would vary with the limits of angular deflection specified for the motors and the time allotted for rotation. Allison claims that the system can be as fast as 1,000 radians per sec.^{2}

Motor size, type of propellant and burning time would also vary with the booster vehicle and the mission. To control the attitude and adjust the velocity of a Nova-type booster, Allison estimates that a system of four motors, developing between 75,000 and 100,000 lb. thrust each would be required. For application to smaller vehicles—such as a Scout or Thor-Delta booster—the company believes that four motors, each with a thrust approximately 1% of the main stage booster, would be sufficient to control the vehicle along all three axes.

The entire system, Allison emphasizes, is within the present state of the solid propellant art. Thrust levels, pro-



FOUR-MOTOR SYSTEM, used by Allison in demonstration tests for NASA, was mounted on a free-floating pedestal within a rigid tower. Springs and weights were attached to the system by the overhead pulley to introduce errors for the system to correct.

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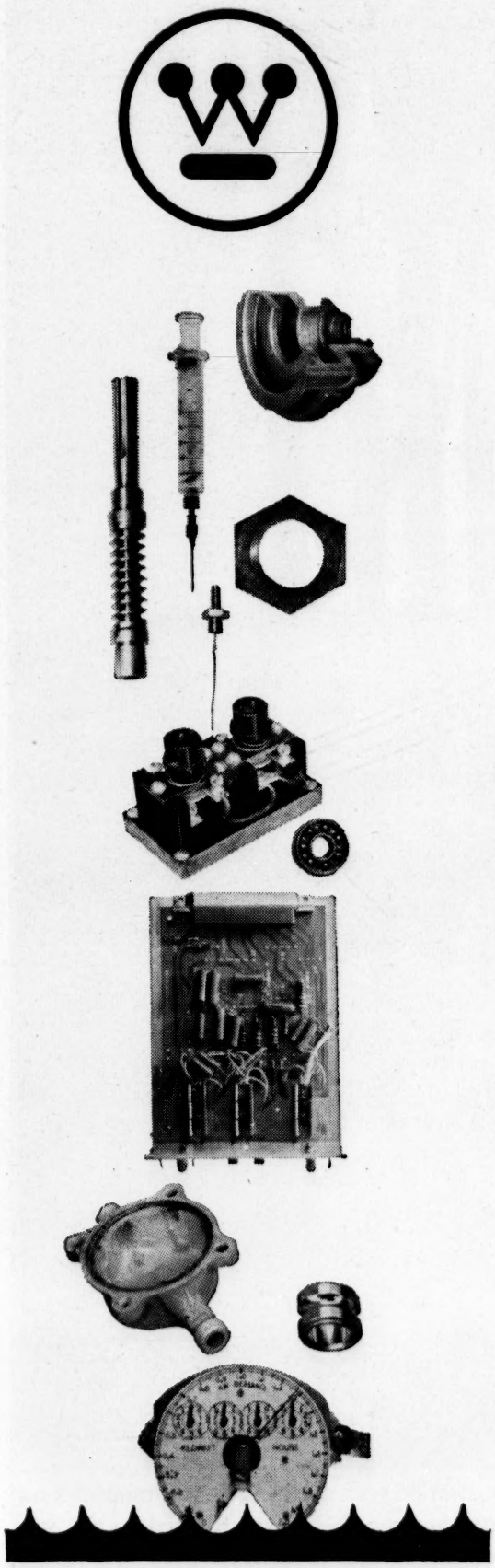
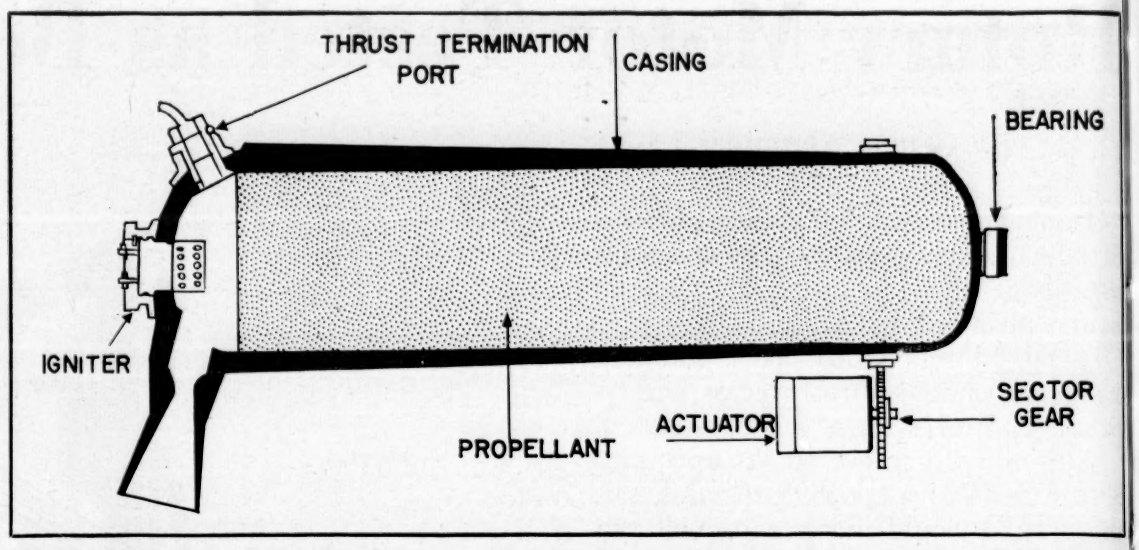




CUTAWAY of the basic thrust vector and attitude control motor being developed by Allison for large booster applications shows end-burning propellant grain and component parts. Motors are rotated about their longitudinal axis, the least moment of inertia, to reduce actuator size and force required.

pellants and burning times of the motors would all be dependent upon the system's requirements—high thrust over 60 to 150 sec. when used primarily as the TVC unit on a large first-stage booster or low thrust over many hundreds of seconds when used to control a deep space probe whose flight profile calls for long coast periods between ignitions of upper stages.

The motor is a basic, end-burning grain design. The nozzles are fitted at right angles to the casing to allow for rotation of the motor along its longitudinal axis. Thrust termination is achieved by blowing out a port upon command from the guidance and control system. The blowout port is essentially a second nozzle, located 180 deg. from the main exhaust cone. Resultant force, after blowout, can be either neutral, negative or slightly positive as required for velocity control, coast or stage separation stability purposes. In tests, Allison says it demonstrated thrust cutoffs within 1 fps. of the desired velocity.

The flexibility of the system, Allison believes, allows it to be mounted either as an individual control unit for each stage of a multi-stage vehicle or as the single TVC system for a vehicle when carried just below the payload. In the latter—or head-end mounted—arrangement, the company points out that a great amount of inter-stage cabling could be eliminated and vehicle bending effects reduced.

Reliability Advantage

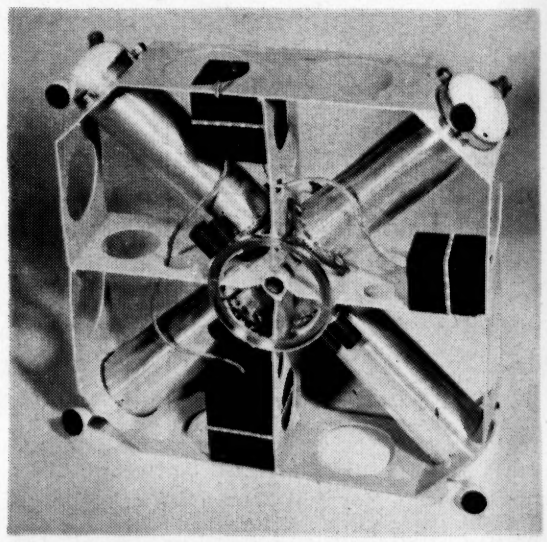
Allison feels that a head-end system would increase the over-all reliability of the vehicle, even when the attendant problems of heavier support structures and shielding for the upper stages are considered. The company proposes that its system—in any configuration—would be ignited 2 to 5 sec. before main stage ignition so that it could be checked out prior to commitment of the complete booster to launch.

So far, Allison has conducted 20 test firings of this system, mounted on a free-floating pedestal. Thrusts have ranged from 50 to 350 lb. and burning times have been as short as 15 sec. and as long as 140 sec. Propellants, cast in motors of several sizes, have ranged from specific impulses of 230 to 245 sec. and have been of the polyurethane category. Mass fractions have been between 0.65 and 0.85.

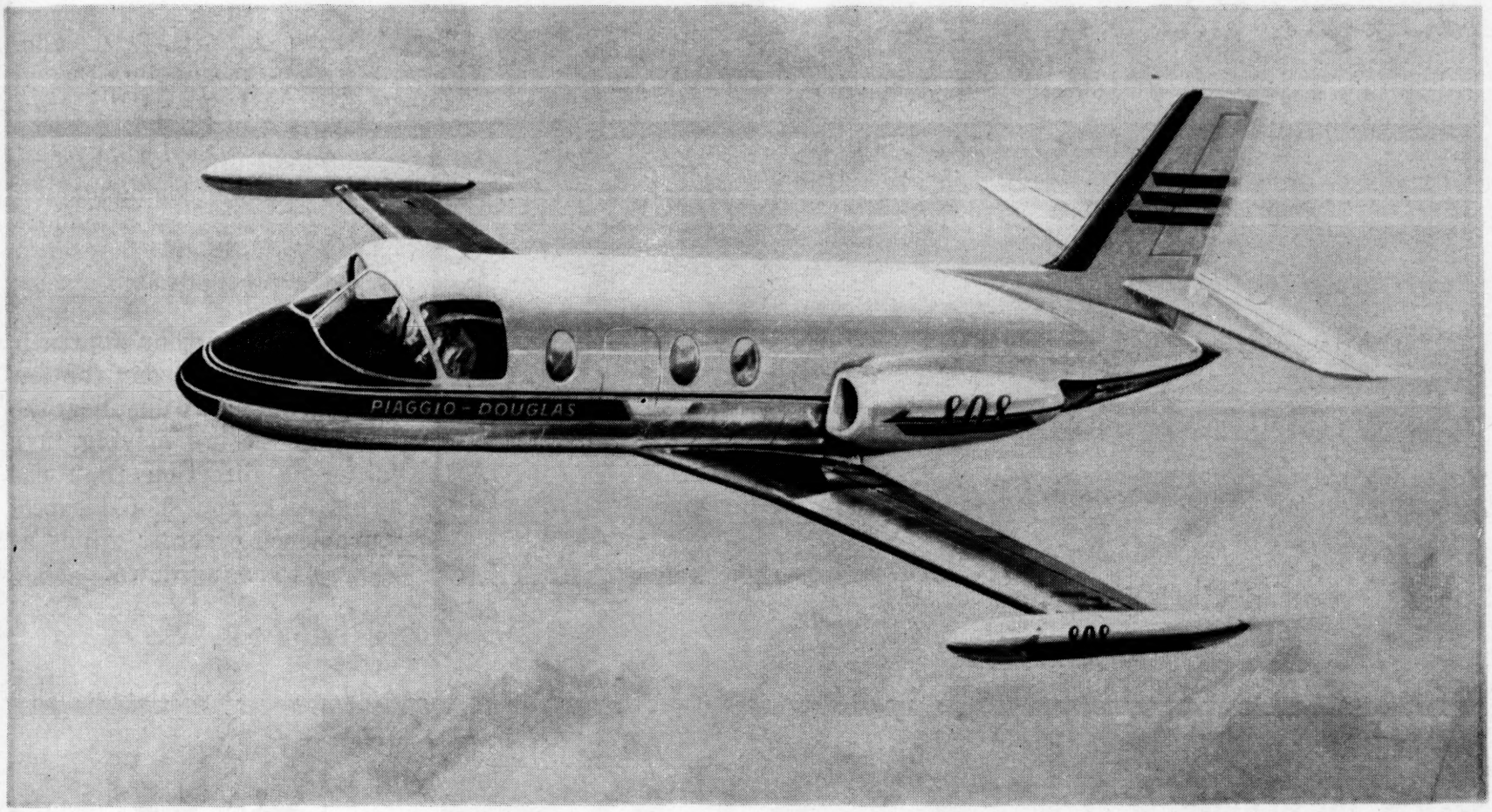
Both the electrical actuators and hydraulic actuators have undergone testing, according to Allison.

NASA Contract

Allison started the project originally with its own funds. About a year ago, the National Aeronautics and Space Administration became interested in the concept and awarded the company a fixed-price contract of almost $200,000 for further testing. Recently, NASA awarded Allison a supplemental contract of approximately $150,000 to continue investigation of low-pressure, long-coast motors.



SMALL SYSTEM suggested for Thor-Delta and Scout systems would be mounted at the head of the launch vehicle. Unit would weigh about 85 lb. loaded with propellant and about 36 lb. at burnout. Thrust would be about 40 lb. over 80 sec.



PIAGGIO-DOUGLAS PD-808 is one of the new turbojet executive aircraft invading the medium-heavy twin-engine field in the business aircraft market. The 6-to-10 place aircraft will be built in Italy with first deliveries scheduled for 1963. First flight is expected in late 1962. Preliminary design work was done at Douglas U. S. facilities; detail design is being completed in Italy.

Turbine Executive Aircraft Gain Impetus

By Erwin J. Bulban

Tulsa, Okla.—Travel revolution imposed by airline turbojet aircraft is threatening to reduce the use of medium and heavy twin-engine, piston-powered aircraft to the point where it will no longer be profitable for businesses to own them, Tom Harris, vice president and general manager of Aero Commander, Inc., indicated to members of the National Business Aircraft Assn. at the group's 14th annual meeting here.

Both business aircraft operators and manufacturers must soon make decisions regarding the purchase and development of turbine-powered aircraft, he said.

Turbine Penetration

Harris' statements, as well as those of other speakers, left little doubt that the business aircraft turbine race is in full swing on a broader scale than ever before. Turbine-powered equipment is rapidly penetrating the medium-heavy twin class, from the Beech 18 up to the World War II surplus conversions of the C-47, Lodestar and B-26, which have so far dominated the market.

Turbine-powered airplanes, both actual hardware and projects, outnumber the piston-powered types they aim to replace. Formerly the piston aircraft held top position at this meeting place of bluechip operators.

Initial penetration by the jet into the upper scale of this market has been made by the now-available four engine Lockheed JetStar, the Grumman Gulfstream, Fairchild F-27 and Convair 340/440 turboprops. Indications are that there could be little further competition by any new entries in this weight class primarily because it appears that there no longer exists a sufficient market to support the costs of further development and sales programs.

Indications are strong, in fact, that the twin-engine turboprops are already cresting the top of their sales potential and only a substantial military order soon will enable these manufacturers to continue at their current production pace. Without such an assist, it appears that although sales to business operators are still possible, these would probably be at such a reduced rate in the year ahead that serious economic problems would confront the manufacturers. Certification and beginning of delivery of production JetStars introduces a competitive factor that the turboprop aircraft makers have previously not had to cope with. First corporate JetStar was delivered to Continental Oil Co. late last month and approximately 18 will be delivered by the end of this year, about one-third for military use.

Lockheed-Marietta spokesmen claim that the company now has sold 43 of the transports, of which approximately 25% are going to the military. Production is at the rate of about two a month, with 35 fuselages already off their jigs and moving down the assembly line.

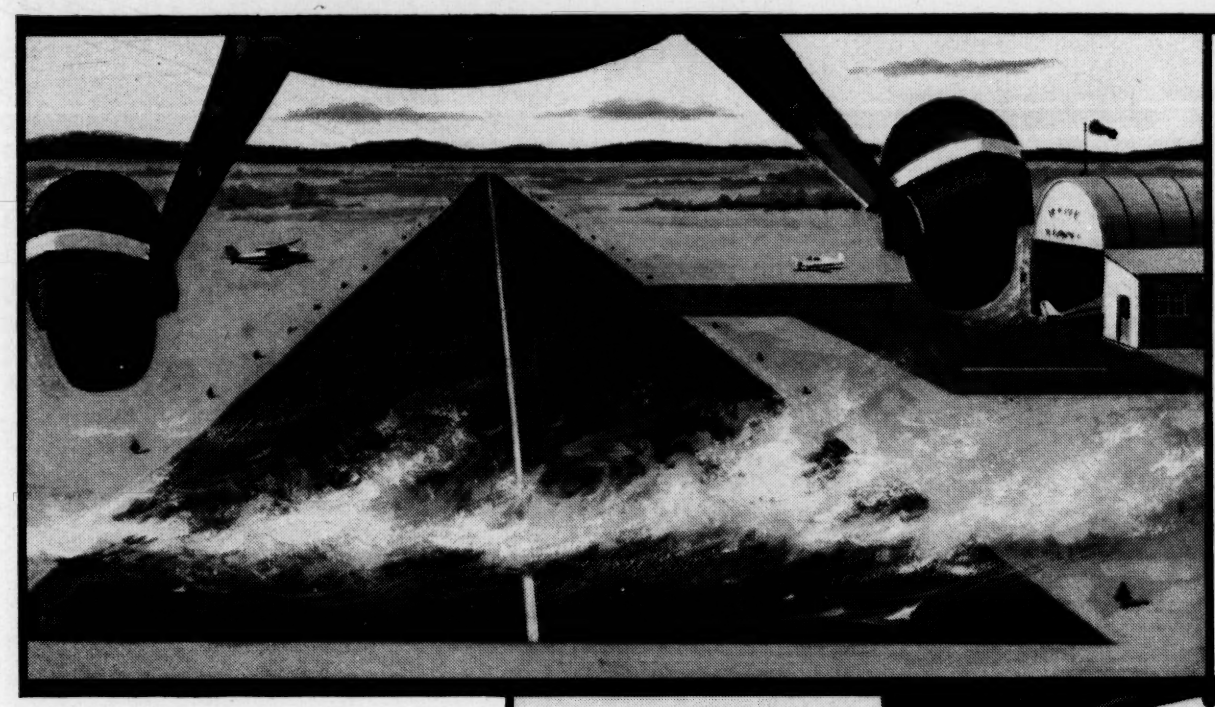
Turbojet Gulfstream

Grumman Aircraft is aware of this competition from the turbojet in its market class and already has developed a follow-on jet version of the turboprop Gulfstream, to keep its airplane in the picture. Basically, this program would provide purchasers of the turboprop model with the capability of later having their airplanes modernized by the addition of four General Electric CF-700 fan engines hung under new wings embodying 18-deg. sweep and new landing gear.

Most attractive way to approach this model, according to a Grumman spokesman, would be for Gulfstream buyers to accumulate some three years depreciation writeoff on their turboprop airplanes, making it easier to justify the modification cost of approximately $400,000-$500,000.

The new designs discussed at NBAA

WING TIPS



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While making your approach, keep a keen eye out for low level, wind-blown dust near the runway. If it's moving in a different direction than the wind sock, you should expect turbulence or cross winds as you're touching down.

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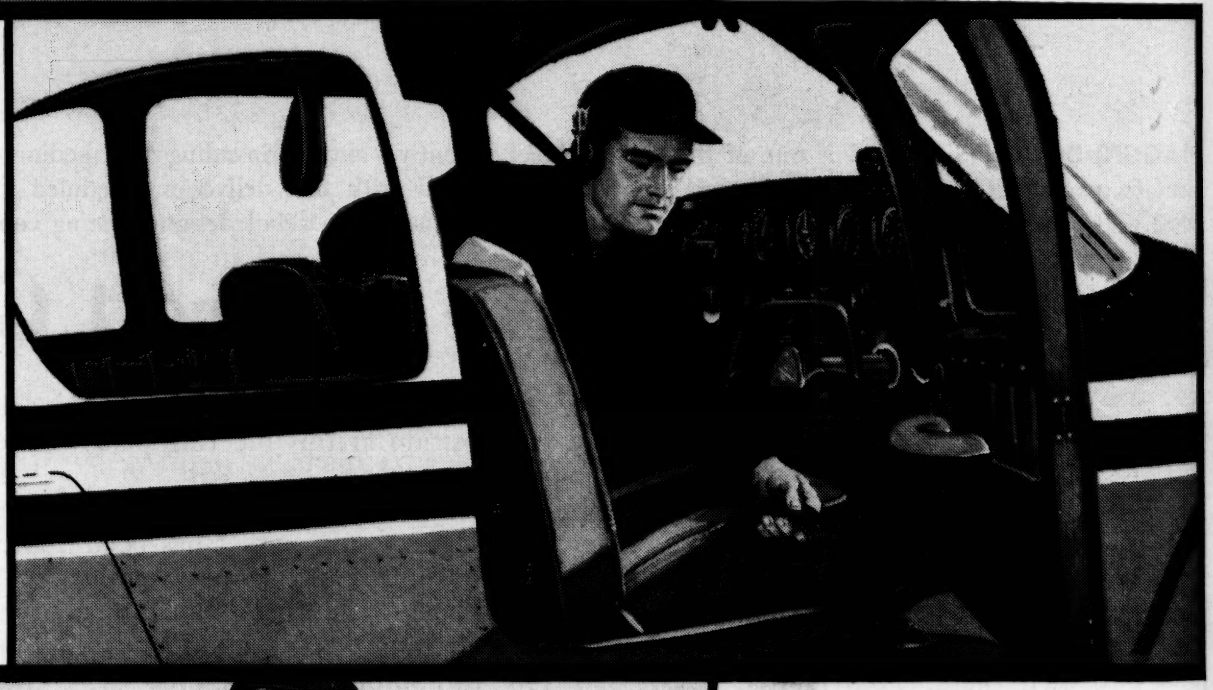
Sounds fantastic, but many a carefree pilot has taken off with a seat belt dangling out the door of his plane. In flight, a dangling seat belt can create terrific noise – even damage – as it raps against your fuselage. So keep seat belts inside . . . and fasten 'em!



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are aimed at reaching further down the weight scale to a broader market and widening the impact of the turbine on business flying. These smaller twin turbine-powered airplanes will have a competitive influence on current piston-powered types in the Aero Commander and Beech 18 range and are directly responsible for putting pressure on these two established business flying manufacturers to make their recent decisions to go-ahead with firm development programs. Indications are that the Jet Commander 1121 probably played a major role in Beech's recent decision to firmly commit itself to a six-to-eight-place turboprop with deliveries anticipated in 1964 (AW Oct. 2, p. 29). The Commander looks most likely to threaten Beech's long-standing role in supplying this particular category airplane and the Wichita manufacturer cannot afford to be ousted from this market.

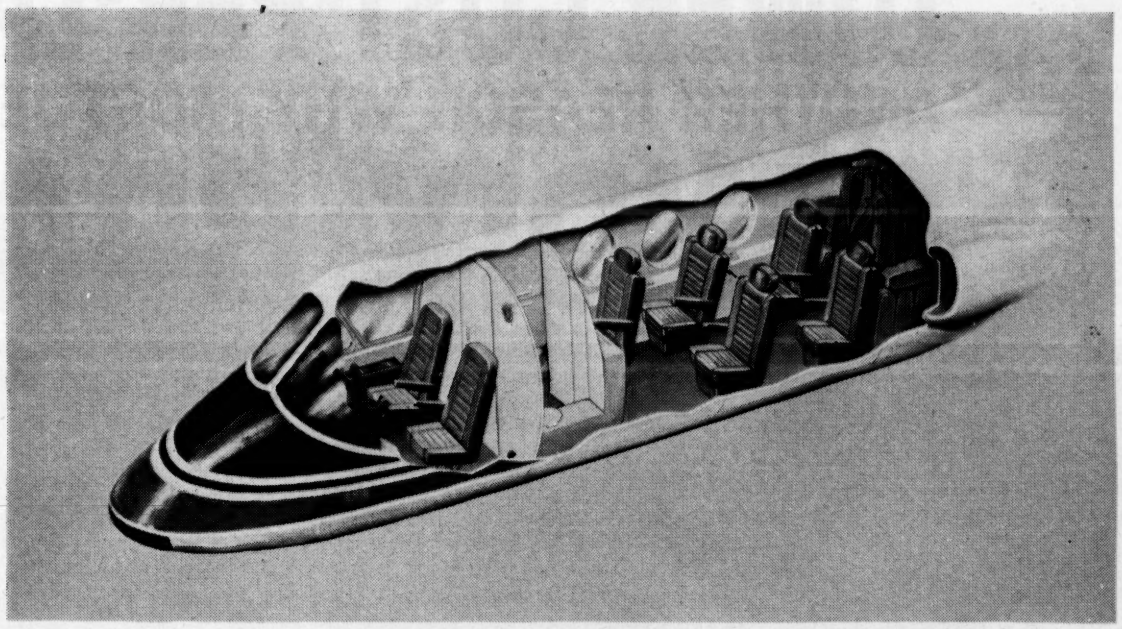
The new line-up of entries, including Beech's, in this light jet field, brings the total of designs and projects to eight and foreshadows a stiff competition for survival over the next few years, since it is unlikely that the market can support even half this number. Of the established business aircraft manufacturers, two major firms have not yet done any talking about their turbine plans—Cessna and Piper.

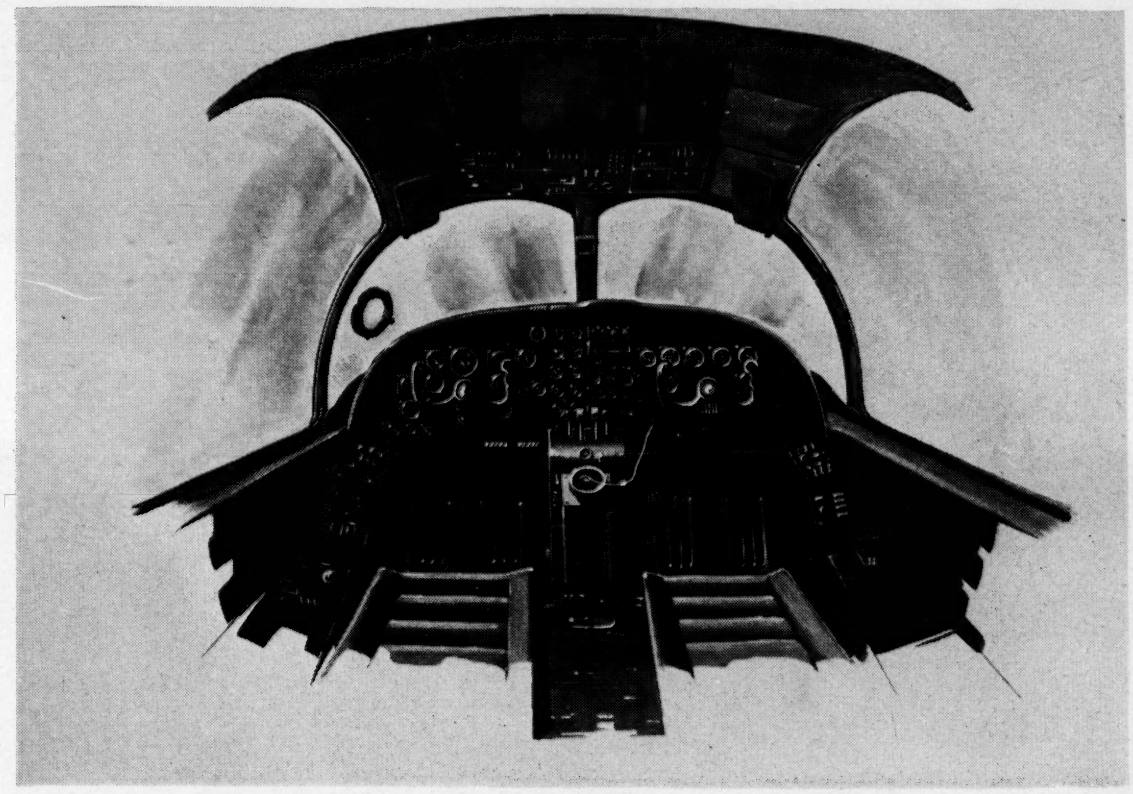
A high-level management source with Cessna told AVIATION WEEK that the company has spent considerable money and engineering man-hours on a wide variety of configurations, but that it was unlikely any announcement regarding a firm commitment would be forthcoming, at least for some time. Prime reason for this is that Cessna feels that the current jet race does not yet threaten its piston line and therefore is not yet competitive. This same thinking would probably also apply to Piper.

Outside Impetus

There are also indications that this business aircraft turbine race is accelerating faster than many manufacturers and aircraft operators would like, but a major part of the impetus is being supplied from the outside by the speed differential now provided by the airline jet fleet compared to the current piston engine business fleet.

It is becoming increasingly difficult for companies to continue to justify their larger types of long-range company planes in view of the halving of past long-range schedules by the carriers. To meet competition from firms who use the jets for business trips, the piston-engine business airplane is being used more and more as a feeder to connect with the nearest airline jet terminal. This pressure will increase further when the airlines expand their jet operations to shorter route segments with the Sud Caravelle and Boeing 727 class airplanes.





SEVEN-SEAT INTERIOR of Piaggio-Douglas PD-808 (above) is one of two versions developed for the aircraft. Ten-seat interior eliminates compartment between passengers and crew. Cockpit, below, is relatively uncluttered.

This will put a burden of justification on those companies whose operational segments are in the 500-mi. category, basically the range parameter included in the specifications of the new generation of light jets. Industry observers feel that many companies will have to use turbine aircraft or reduce their activities by using smaller aircraft, or even get out of the business aircraft picture. Additional pressure will be generated by some of their competitors who already have jet equipment—150 to 200 turboprop and turbojet business planes should be operational in the Western Hemisphere next year—and by the decreasing value of the piston plane as a status symbol in an age of jets.

Of the light turbine newcomers, only two are turboprops—the Beech 6-8 seater and the French Potez P.840, which is expected to make its U.S. debut this April or May under the sponsorship of Don Payton's Turbo-Flight, Inc., U.S. distributor for the four-engine airplane. The airplane, which will be certificated at a gross weight of 19,600 lb., will sell for $460,000 here plus a $40,000 import duty. Initial customer deliveries can be made in the third quarter of 1962 if ordered by the first quarter of 1962 (AW Oct. 2, p. 84).

Aero Commander appears to have a head start on production of the first U.S. light turbojet built expressly for the business owner. AVIATION WEEK was told that the company already has two firm production line positions assigned to corporate buyers, with nine additional orders under negotiation.

A dark horse in the light jet executive stable appears to be William Lear's Swiss American Aviation Corp. SAAC-23, primarily because of the price he quoted here—$250,000 for a basic airplane, flyaway Alternrhein, Switzerland, minus electronics, interior, autopilot, instruments or auxiliary power unit providing ground air conditioning.

Lear maintains that he will be able

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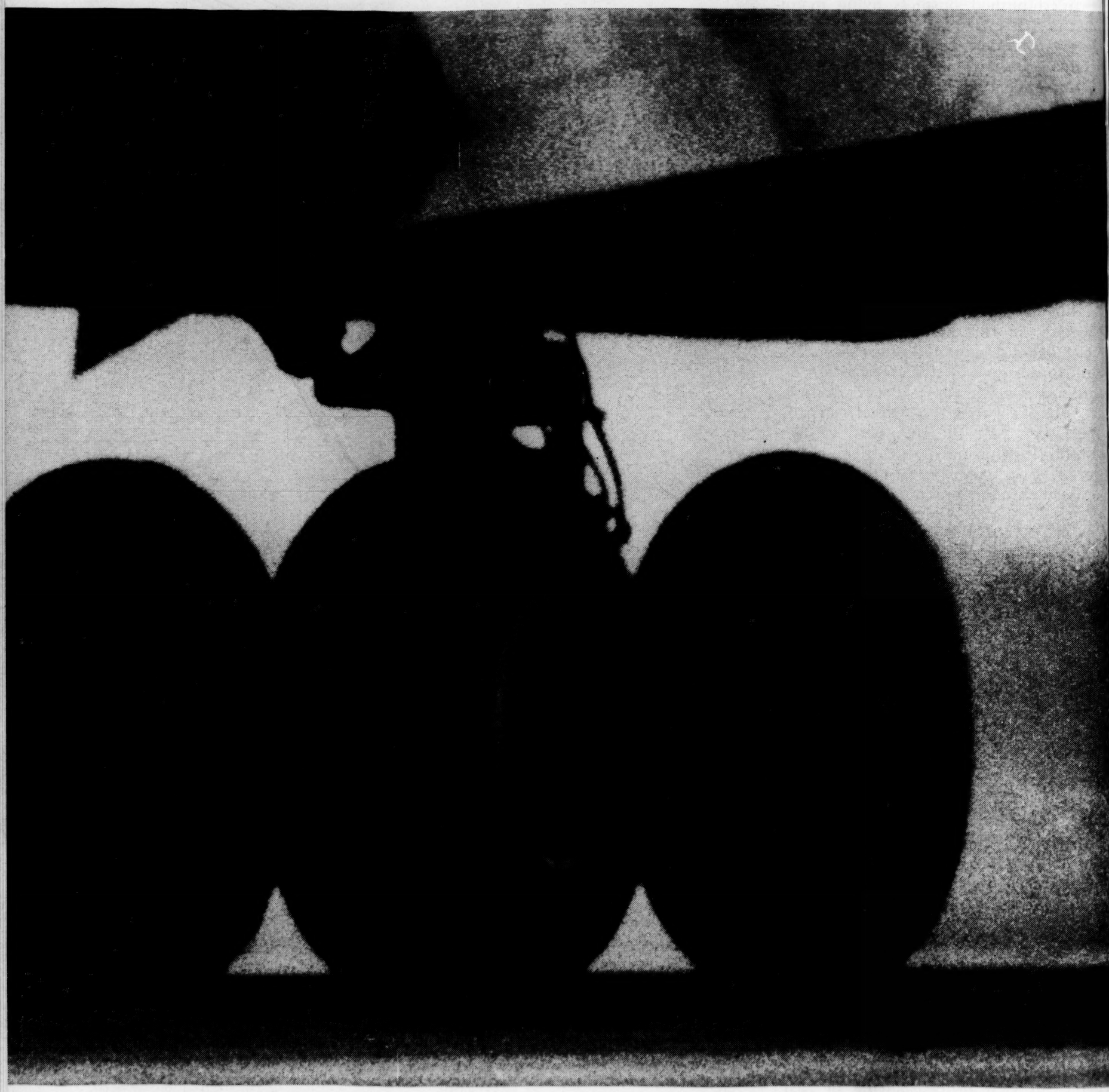

One airline averaged per-landing brake costs of only 86.7¢ in 30 months with Bendix. Another line reports 85¢ cost-per-landing in 30 months. Figures like these show why many jets today rely on brakes by Bendix—world's most experienced brake manufacturer. These dependable units also give improved pilot control and greatly reduce turn-around time.

Bendix Products Division

THE Bendix CORPORATION

Modification Center

Tulsa, Okla.—Certification center that would establish standards for aircraft modifications is planned by Federal Aviation Agency at its Oklahoma City Aeronautical Center, according to Administrator Najeeb Halaby.

Although the operations will be concerned with passing on all aircraft modification programs, the supplemental type certificate work done on business aircraft probably would form a major chore at the facility. Motive for setting up such an operation, according to Halaby, would be to provide a "one-stop" operation that could analyze and test for approval modification programs which now meet with varied opinions, according to industry sources, depending upon the FAA region in which approval is sought. The center would establish basic criteria by aircraft model and approve or disapprove modification work, on the basis of actual flight test programs conducted under FAA supervision.

to meet this low price schedule—fully equipped, he says, the airplane will cost approximately $350,000, which would be some $200,000 less than its contemporary jet competition—by maintaining a tight grip on overhead and engineering costs. This includes utilizing some components already proven in the Swiss P.16 jet fighter, using top-flight engineering talent on a job-contract basis and considerable use of low-cost European computer time for much of the design analysis.

Drawings Released

Lear states that he has already released drawings covering parts for the initial batch of 25 production aircraft and expects to have the first plane, which will also act as a production prototype, flying next April, with certification completed possibly as early as next September. He says production schedules call for delivery of the first 25 SAAC-23s in the first six months of 1963, with a total of 75 units delivered that year. In 1964, he reports, the company will build 100 airplanes and production will be stepped up 20% thereafter. He states that the first pros-

PD-808 Weights

Maximum takeoff weight	15,000 lb.
Maximum landing weight	14,300 lb.
Intermediate flight gross wt. (60% fuel)	12,293 lb.
Landing gross weight (w/reserve)	9,762 lb.
Weight empty	7,527 lb.
Maximum payload	2,000 lb.
Fuel (Incl. tip tanks)	5,428 lb. (835 gal.)

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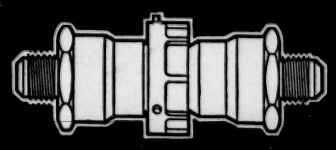

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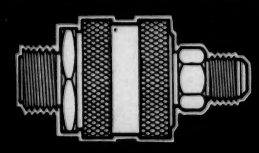

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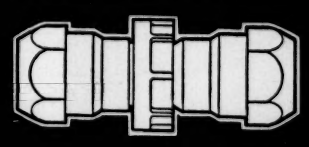

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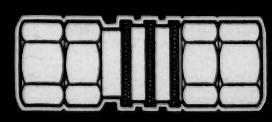

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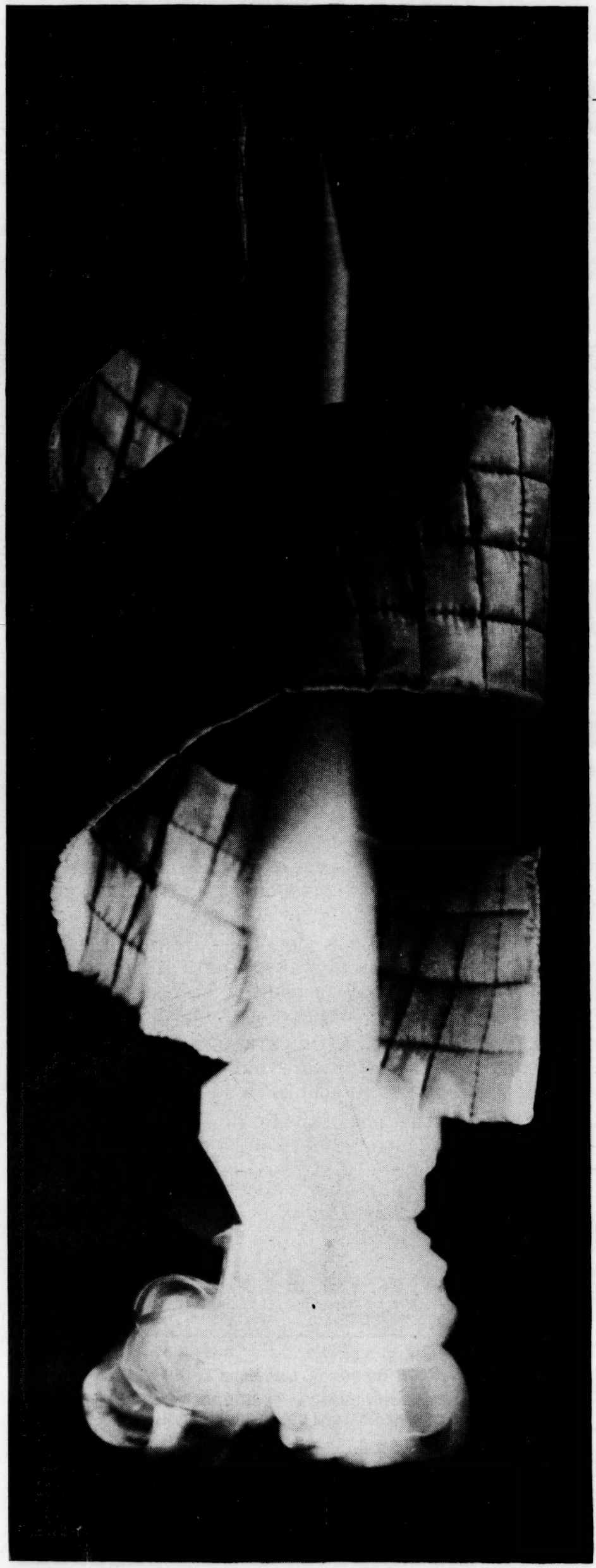

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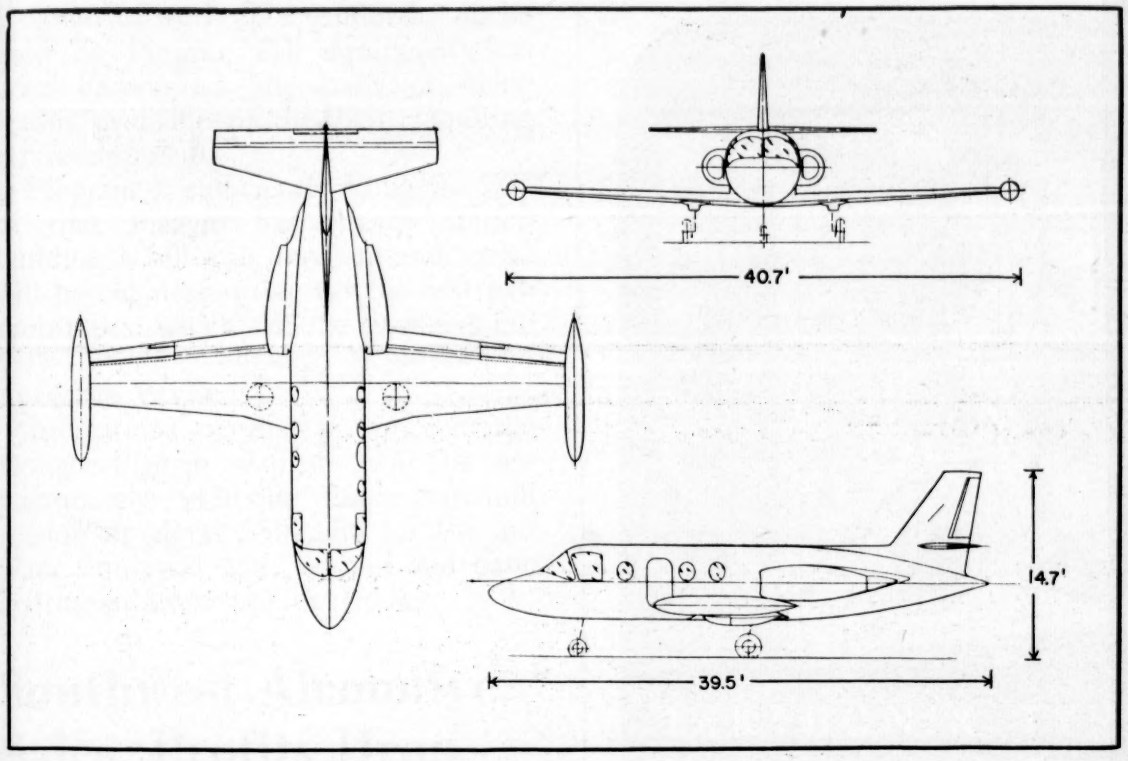


THREE-VIEW OF PIAGGIO-DOUGLAS PD-808 shows "bug-eye" cockpit windows, uniquely faired, aft-mounted engines and tip-mounted fuel tanks.

PD-808 Data

Dimensions

WING	
Area	225 sq. ft.
Span (w/tip tanks)	40.67 ft.
Aileron area	12.1 sq. ft.
Flap type	Single-slotted
Maximum deflection	40 deg.
Tip tank capacity	112.5 gal. each
HORIZONTAL TAIL	
Area	70 sq. ft.
Span	17.83 ft.
VERTICAL TAIL	
Area	36 sq. ft.
Span	7.2 ft.
FUSELAGE	
Frontal area	27.1 sq. ft.
Length	39.5 ft.
CABIN	
Height	57 in.
Length	148 in.
including cockpit	214 in.
Width	64.5 in.
COMPLETE AIRPLANE	
Total wetted area	1,294 sq. ft.

Performance

Engines	Two GE CJ610-1 turbojets
S.L.S. max. takeoff thrust	2,850 lb.
Takeoff speed	142 mph.
Takeoff over 50-ft. obstacle	2,770 ft.
FAA field length	4,020 ft.
Max. cruise speed (40,000 ft.)	520 mph.
Service ceiling	46,500 ft.
One engine inoperative	29,000 ft.
Power off stall speed (at landing gross weight)	91 mph.
Approach speed	119 mph.
Landing over 50-ft. obstacle	2,350 ft.
FAA field length	3,900 ft.
Rate of climb at S.L.	7,440 fpm.
One engine inoperative	2,375 fpm.
Landing sinking speed (design)	10 fps.
Maximum flight duration	4 hr.

pect for the new airplane has indicated he will take three units.

Lear expects that he will get military orders for the SAAC-23, noting that the airplane will have a capability not only for high speed VIP transport and some training missions, but will also be adaptable to tactical combat. It is stressed to carry out over-the-shoulder nuclear weapons delivery maneuvers as well as air-to-ground rocket attack, with packs carrying up to 96 2.75-in. missiles.

To handle the Western Hemisphere market, Lear said that he plans to select a U. S. assembly site somewhere in the Midwest, possibly deciding on a location in the next month. This facility would employ approximately 100 people when in full-scale operation and will use duplicate tooling now being built in Switzerland. Complete set of production and assembly tooling for the SAAC-23 is expected to be ready in May, 1963.

Stepped-up Efforts

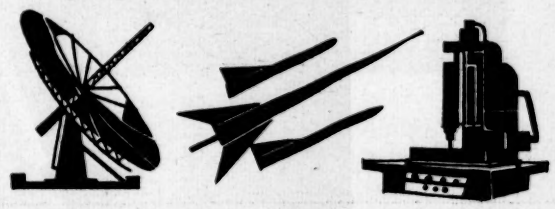
Douglas Aircraft Co. is stepping up its efforts to get the PD-808 six-to-ten-place twin-jet executive transport program underway at its licensee, Piaggio Co., near Genoa, Italy.

Plans call for flight testing the first airplane late next year and first deliveries in 1963. The 500-mph.-plus cruise transport will be powered by two General Electric CJ610-1 or Bristol Armstrong Siddeley Viper 20 engines.

Preliminary design on the two-year-old Douglas project has been completed and detail design work is being started at Piaggio. The first of a team of Douglas specialist engineers already has left for Italy and PD-808 Project Engineer Floyd C. Newton, Jr., was scheduled to leave this month. Douglas engineers already have gone through the systems

Servo motor needed Found

for radar, missiles, machine tools



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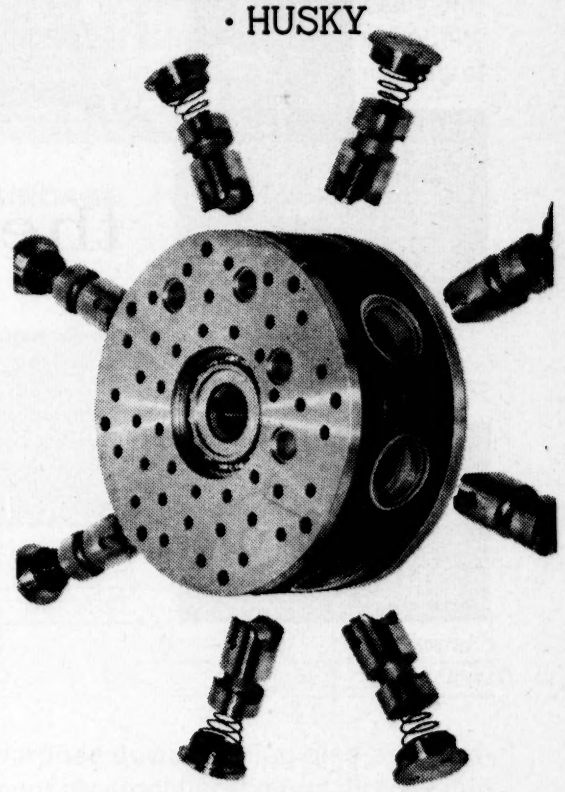

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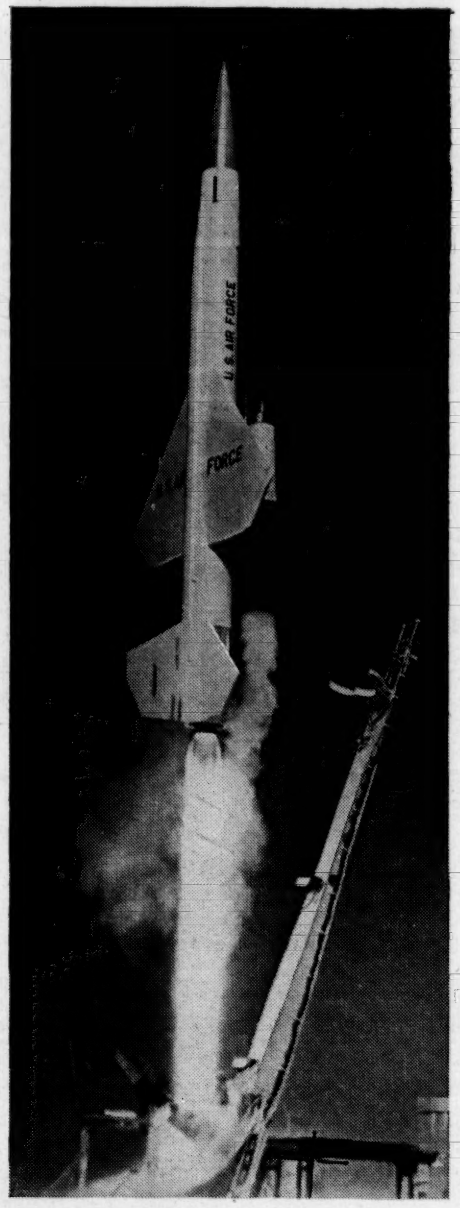

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program to work up a vendor list to be used by Piaggio. All equipment has been chosen on the basis of being readily available off-the-shelf, requiring no development.

Program is sufficiently along the way so that Piaggio has already started building a full-scale mockup and metal will be cut next spring for the first two prototypes, which will be powered initially by Viper engines, Newston told AVIATION WEEK.

Indications are that the price of the Douglas-Piaggio airplane will be approximately $450,000 for a bare-hull version or about $500,000 for the airplane equipped with interior and basic instrumentation and electronics.

Southwest Airmotive Sales, Profits Drop

Dallas, Tex.—Downtrend in sales and earnings in the fiscal year just past are noted by Southwest Airmotive Co. compared with the similar previous period and are attributed to over-all effects of the U. S. business recession and the completion of parts provisioning by the supplier's airline jet customers.

Southwest Airmotive executives noted that the last quarter of the fiscal year showed a pickup in business resulting in a highly profitable period, with profits before taxes averaging nearly $100,000 monthly in the period February through May 31, 1961. Profits in the last six months were about seven times greater than the last half of Fiscal 1959-1960.

Gross sales for the recently concluded fiscal year totaled $11,925,129 compared with $12,541,889 for the previous year, with net income being $207,881 compared with the previous year's $416,358.

Earnings per share were 20 cents as against 41 cents for the 1959-1960 fiscal year.

Supply sales to airlines were under the previous year's high level, but a gain of 9% was recorded in parts and equipment sales to business and private plane dealers and the company's shop work was up 8%.

Upward curve in the latter quarter of the fiscal year past is attributed largely to increased business in overhauling airline jet engines and the reduction in manhours at its jet engine shops as the learning curve improves. Airline jet equipment expansion programs are seen as further brightening the picture for future work.

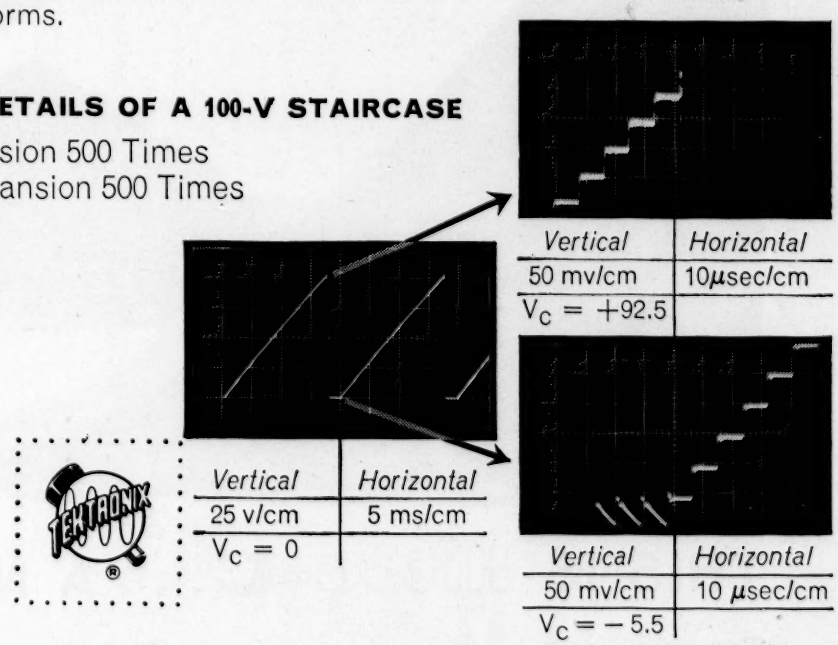
Southwest Airmotive now overhauls Pratt & Whitney J57 and J75 turbine turbojets for Braniff, Eastern, National and Northwest Airlines. Overhaul contracts for airline jet engines are up 50% over the previous year.

New differential plug-in preamplifier rejects up to 100 v of an input signal . . . accepts 100-v waveforms for oscilloscope display at 50-mv/cm sensitivity . . . provides an equivalent vertical scale length of ±2000 centimeters.

You can now display small segments of large waveforms at maximum oscilloscope sensitivity, with vertical expansion equivalent to as much as 500 times. You can select magnified "window" displays of all portions of a waveform, and make amplitude measurements with a degree of accuracy that closely approaches the possibilities of digital techniques. The flexibility and simplicity of the analog (oscilloscope) presentation is retained for accurate analyses of complex waveforms.

WAVEFORM DETAILS OF A 100-V STAIRCASE

Vertical Expansion 500 Times
Horizontal Expansion 500 Times



The new Type Z Plug-In Unit is a triple-purpose device, acting also as a conventional preamplifier and a differential-input preamplifier. It plugs directly into all Tektronix Type 530, 540, and 550 Series Oscilloscopes and fits into the Type 81 Plug-In Adapter for use with the Tektronix Type 580 Series Oscilloscopes.

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Czechs Designing New Line of Lightplanes

By Edith Walford

Brno, Czechoslovakia—Czech aircraft industry is designing a new line of light aircraft and studying plans to move into the turbine-powered helicopter field for domestic use and export in the late 1960s.

New vehicles envisaged include a replacement for the high-wing L-60 Brigadyr aircraft and a small two-seat helicopter designated the Z-35 for postal services in remote areas.

The Czechs also reportedly are designing a piston-engine V/STOL tilt-wing light aircraft for use over the same period (AW Sept. 18, p. 23).

General plans for the future were outlined to AVIATION WEEK during the recent Third International Brno Trade Fair by officials of Omnipol Foreign Trade Corp., the Czech government agency responsible for export sales of light aircraft and related products.

A decision has been made to forestall production of the new, heavier six-seat version in the industry's HC helicopter series, the HC-3, powered by a 240-hp. piston engine developed by the Moravan Aircraft Works, Ostrokovice. Nor will any large numbers of its HC-2 Heli-Baby predecessor be built until sufficient markets to warrant quantity production are assured for either or both in accordance with government policy, Omnipol said.

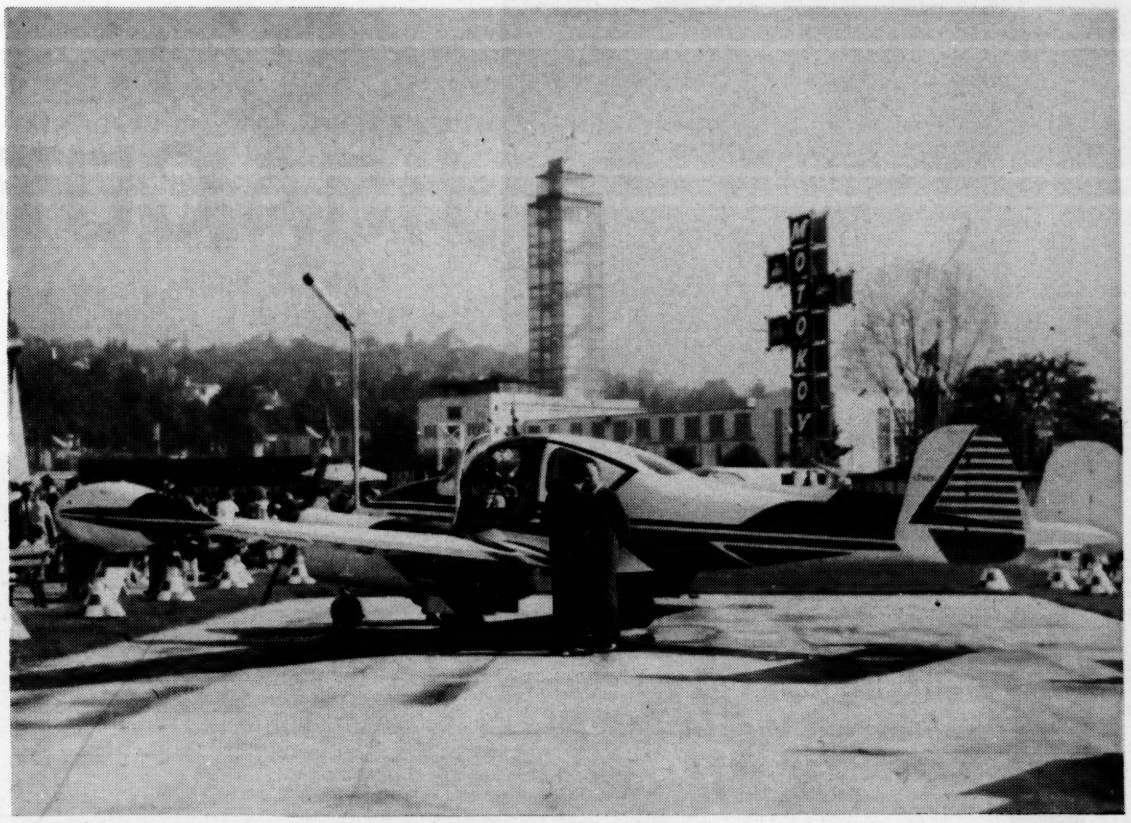
Design of a replacement for the Brigadyr utility aircraft first produced in 1957 is now under way, "or we might decide to take a Polish model," an Omnipol spokesman said.

At an international conference in Prague earlier this year, government delegates and aviation industry experts discussed the type of aircraft needed to replace the Brigadyr.

It was decided that, unlike the multi-purpose Brigadyr, the new prototype should be designed for agricultural use only. It also should meet as far as possible these specifications:

- **60% of the gross weight** would constitute total empty weight of the one to two prototypes to be developed.
- **30% would be the weight** of the chemical spray solution carried.
- **Remaining 10%** would be fuel.
- **Chemical solution** to be chosen must be suitable for either spraying or dusting.
- **Aircraft should be** of lightweight metal construction to eliminate corrosion and also for reasons of economy. Use of new alloys or synthetic materials is under consideration.

No decision was reached at the conference on two remaining questions on the agenda—type of powerplant and whether the aircraft should be a high or low-wing design.



TWIN-ENGINE L-200 Moravas are replacing the Aero 145s for multi-purpose duties including business flying, ambulance work and aerial surveying.

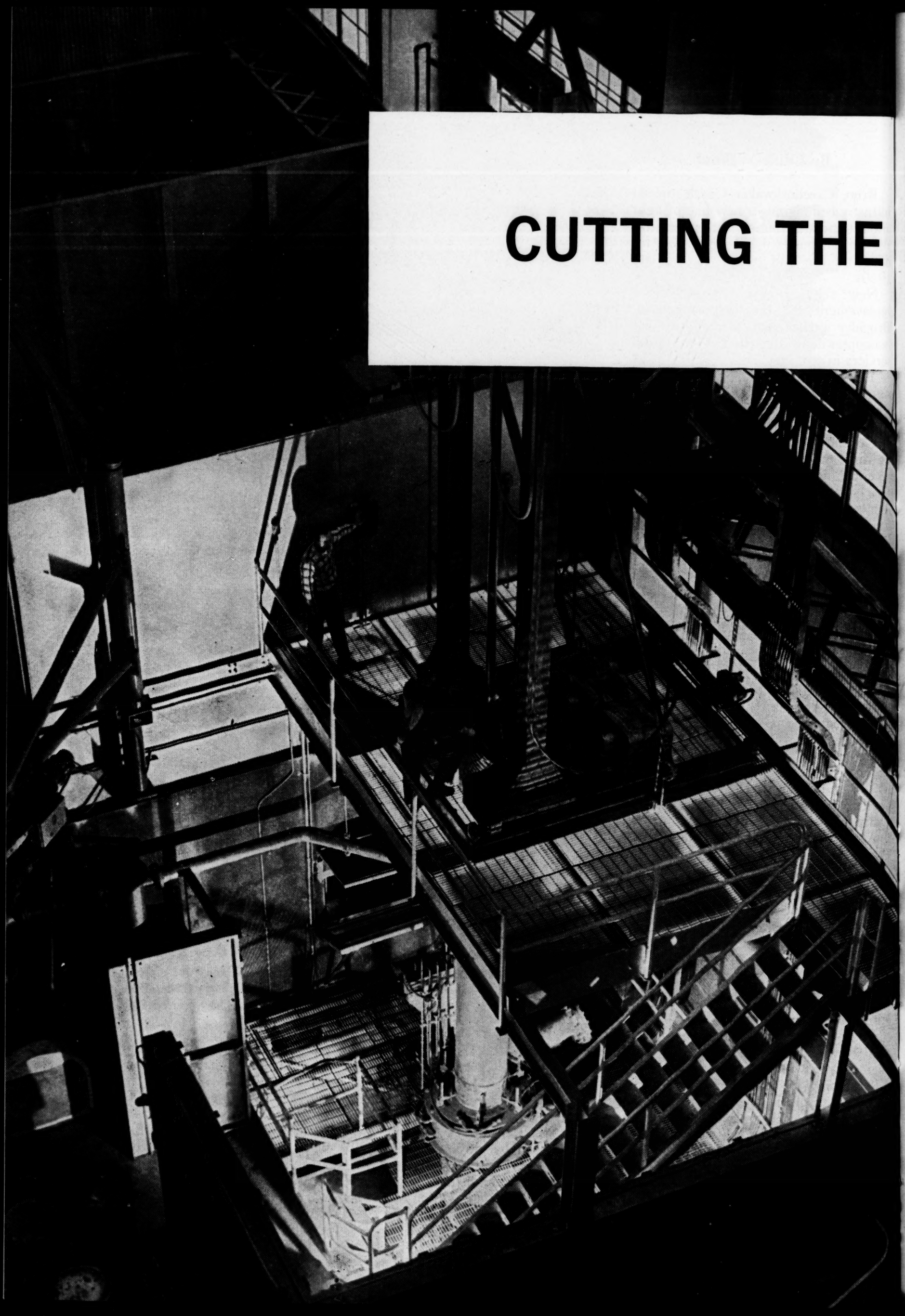
ALL-METAL two-seat tandem L-13 Blanik sailplane is being marketed in tropical countries where the normal plywood construction used in such aircraft does not withstand the extreme temperatures as well as metal. Of the 300 Blaniks built, Russia has received 200.

It was finally agreed, however, that until the end of the Third Five Year Plan in 1965, all Eastern-bloc countries will continue to use the present range of light aircraft. New types will only be made available during the 1965-70 period. It also was agreed that the rate of development of existing airports and construction of others within Czechoslovakia must be accelerated.

Airport lighting equipment for export was the main feature in the aircraft section of this year's trade fair at Brno. Only four of the seven different types of light aircraft shown on the two previous occasions at Brno were displayed. These were the L-200 Morava the Z-326 Trener Master, the L-40 Meta-Sokol and the L-13 Blanik sailplane plus the widely exported Herkules III motor winch.

An Omnipol official explained that it was government policy to show at the Brno Fair only production aircraft readily available to prospective buyers.

The Aero 145 twin-engine, four-seat



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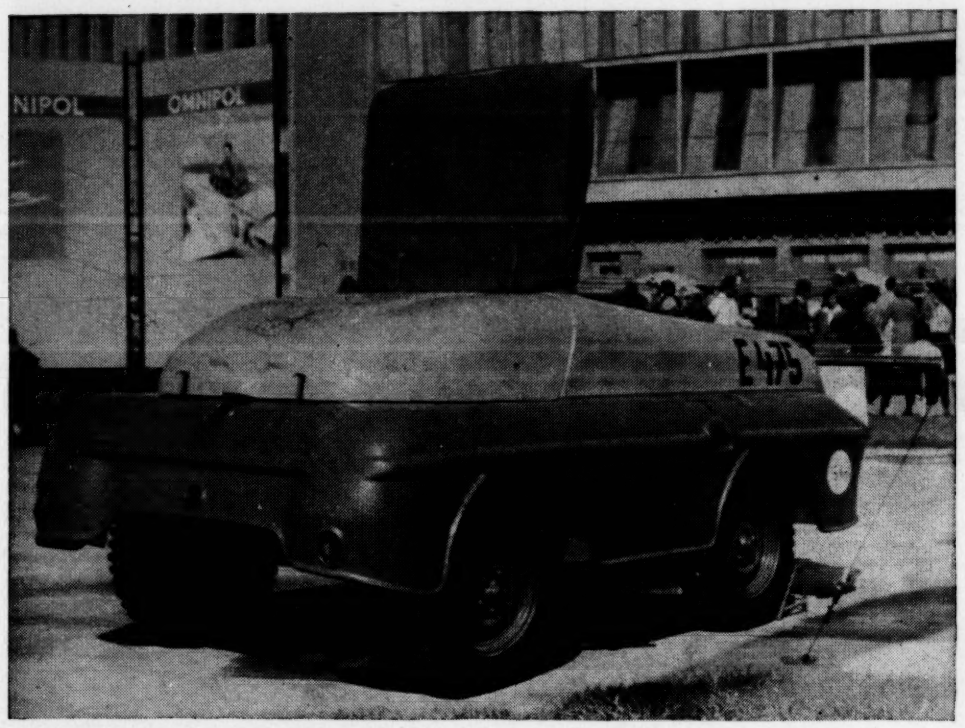

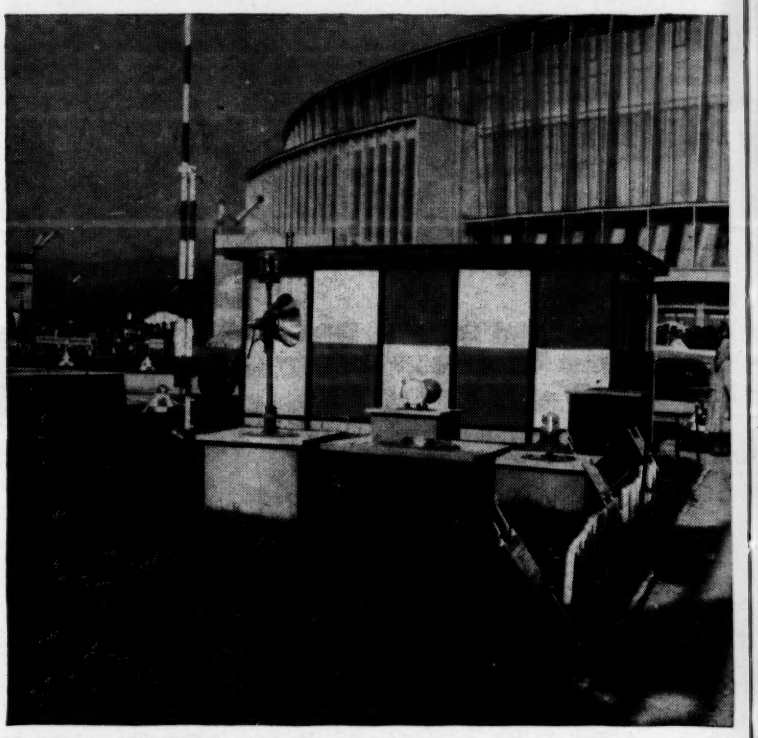

CZECH-BUILT, SELF-PROPELLED two drum Herkules III motor winch is fitted with a TATRA 108 diesel engine rated at 134 hp. (left). A total of about 400 will have been produced by the end of this year. Section of Czech-built airport lighting equipment (right), occupied first place among the outdoor aviation exhibits at this year's Brno Trade Fair. Although not shown in photo, the equipment includes flush-mounted runway lights and flush-mounted omni-directional lights.

lightplane, the high-wing, four-seat L-60 Brigadyr and the HC-2 Heli-Baby two-seat, general-purpose helicopter were missing among the exhibits at Brno this year.

A total of about 700 of the Aero series, including the Aero 45 and Super Aero I and II, have been produced since 1947, of which about 80 were sold to Czech users, the remainder to various foreign customers. Production of this type was discontinued last fall, by which time the four-to-five seat L-200 Morava, introduced in 1959, had proved its worth as a suitable replacement. Thus far, approximately 400 Moravas have been built. Of these, 50 were sold to Czech customers, particularly to CSA Czechoslovak Airlines for its growing air taxi operations, and 300 were exported, leaving Omnipol with 50 Moravas as reserve aircraft.

Production of the L-60 Brigadyr utility aircraft was discontinued because this type is "too old and uneconomical for present requirements, and the Czech market is saturated for the next two-to-three years," Omnipol said. Between 1957 and 1960, a total of 400 of this type were built and half of them exported.

To date, about 1,000 Trener Master aircraft have been produced. Of these, approximately 200 are in use in Czechoslovakia, while the rest were sold abroad. Introduced in 1948 was the Z-226 Trener Master from which the present version, the Z-326, is derived. Of the aircraft built, 252 were Z-226s. This two-seat tandem, low-wing all-metal aircraft, suitable for both primary and advanced training and for acrobatics, won first place in the First World Acrobatic Championships held at Bratislava, Czechoslovakia, last year. At the Second World Acrobatic Champion Meet held in Coventry, England, earlier this year, a Trener Master again won the event and was awarded the Lockheed Trophy.

Of the 200 L-40 Meta-Sokol sport and touring aircraft built, only a small number are in use with Czech flying clubs. The rest have found a ready market abroad, particularly in West Germany, the Scandinavian countries, England, Australia, Austria, South America and, more recently, Spain.

The Czech all-metal, two-seat tandem L-13 Blanik sailplane built in 1958 found its first export market in Russia in 1959. Thus far, of the approximately 300 produced, the Soviet Union has received 200. Omnipol says the model is becoming increasingly popular in tropical countries and that Chile, one of the latest Blanik customers, has purchased three.

NEW FOUR-STROKE air-cooled engine, designated the M 110 H, suitable as a powerplant for both fixed-wing and small rotary-wing aircraft and for other industrial uses, was displayed at Brno for the first time. Engine has a dry weight of about 202 lb. When adapted as a helicopter powerplant, the complete unit weighs 277 lb.

The Soviet Union also is the best customer for the Czech Herkules III motor winch introduced in 1959. A total of about 400 will have been produced by the end of this year. About 30 or 40 of these are being used domestically, the rest were sold abroad.

First complete set of Czech-built airport lighting installations, which went into series production earlier this year and on which Omnipol is concentrating a major sales effort, was delivered to Russia which has several more on order. All domestic Czech airports also are to be fitted with the lighting equipment as soon as current export orders have been filled. An order has been received from East Germany, and Omnipol said it had received a number of inquiries from Communist China, Africa, and Middle Eastern countries.

Manufactured by Elektrosignal, Prague, special features claimed for the equipment, which include flush-mounted runway and omni-directional lights, are that it results in a saving in materials and labor of approximately 40% as compared with orthodox installations and that, when used at airports with a runway of about 9,840 ft. in length, savings in electrical current per year amount to between 150,000 and 200,000 kw./hr.

The indoor aircraft engine section at Brno again contained models of the Czech-built Walter Minor 140-hp. M 332 and 210-hp. M 337 four-stroke in-line inverted engines, which power the Aero 145s and Moravas respectively and which are now in series production.

A new exhibit on the engine stand was a small powerplant, the aircooled

M 110 H, with a four-stroke cycle and direct propeller drive. It is fitted with a low-pressure injection pump, which sprays fuel through injection nozzles ahead of the intake. Dry weight is approximately 202 lb.

It has been designed as a powerplant for both fixed wing and small rotary wing aircraft as well as industrial uses. According to Omnipol, a small quantity of the new engine is now being produced for the domestic market where it is to be tried out prior to promoting its sale abroad.

PRIVATE LINES

Warranty life on all 1962 model Cessna aircraft will be doubled from three to six months, the company has announced. Complete details on the extended warranty life of the Cessna line will be announced in November.

No major changes have been incorporated into the 1962 Beech Queen Air. The 1962 model has a new paint design, new interior and an additional 10 cu. ft. of cabin space. Lighter materials used in manufacture have increased the useful load to 3,060 lb., Beech says. Basic price will remain at $126,000.

Soviet Union has claimed new speed and altitude records in the jet sport plane category for the Yak 30. Soviet sources said the plane was piloted without commercial weight to an altitude of 16,128 meters (53,000 ft.) and reached a speed of 767 kph. (480 mph.) in a 15-25 km. course. Old altitude record, also held by Soviets, was 14,283 meters (about 47,000 ft.) and original speed record, held by Yugoslavia, was 750.3 kph. (approximately 465 mph.). Data are being sent the Federation Aeronautique Internationale for ratification.

Federal Aviation Agency has approved a pushbutton automatic flight system for the Lockheed JetStar. The system is manufactured by the Sperry Phoenix Co., a division of Sperry Rand Corp. System, designated SP-40, provides pushbutton control of the aircraft and couples the aircraft to radio beams for en route navigation and ILS approaches. The SP-40 weighs approximately 75 lb. and has an optional feature which enables it to navigate the aircraft through a doppler radar system.

State of North Carolina has purchased a Beechcraft Super G18 to aid in its current program to attract industry to the state. Industry leaders will be flown to North Carolina by state government officials and provided with transportation to prospective industry sites.

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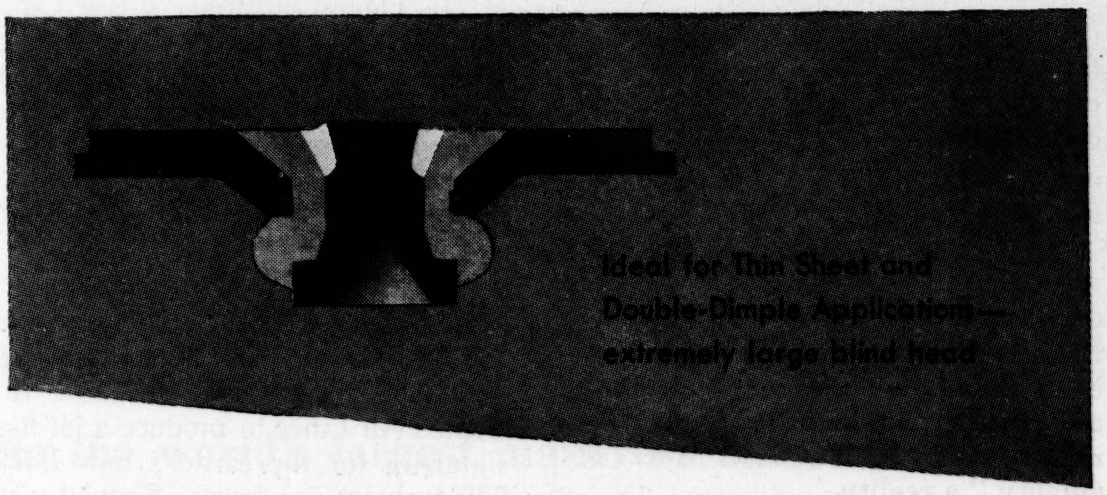

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For technical data on Cherrylock Rivets, write Cherry Rivet Division, Townsend Company, Box 2157N, Santa Ana, California.

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Aircraft and Missile Products Division
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PRODUCTION BRIEFING

Atomic Energy Commission is requesting bids to expand the air storage system for the Tory II-C reactor from 120,000 lb. to one million lb., and to modify related components for testing the Pluto nuclear ramjet rocket. Bids for the job, estimated to cost $6 million, are due Nov. 7 at AEC's Las Vegas, Nev., office.

Rohr Aircraft Corp.'s main plant at Chula Vista, Calif., will produce powerplant nacelles and other components for P3V-1 Orion ASW aircraft through mid-June, 1963, as a result of add-on orders recently received from the Lockheed-California Co.

Avco-Everett Research Laboratory, Everett, Mass., division of Avco Corp., is studying methods for control, maneuver and landing of satellites in predetermined areas under a $307,324 contract from USAF Systems Command's Aeronautical Systems Division. Part of the study is devoted to satellite maneuverability at both subsonic and supersonic velocities.

Dumont Mfg. Corp., subsidiary of H. I. Thompson Fiber Glass Co. of San Rafael, Calif., is producing all-plastic nozzles for first and second stage motors of Army's Pershing missile. Nozzle weighs less than half as much as a metal nozzle of comparable size, reportedly cutting missile weight problems appreciably.

Link Division of General Precision, Inc., Binghamton, N. Y., has received a contract exceeding $1 million from United Air Lines to produce a jet flight simulator for the carrier's new Boeing 727 turbojet transports. Simulator will be located at United's training center in Denver, Colo.

Magnasync Corp., North Hollywood, Calif., is producing 300 Model T-1510 recording systems and 141 reproducers for use at Military Air Transport Service installations world-wide. The systems, under a USAF contract totaling $1,554,611, can handle up to 50 simultaneous aircraft-to-tower conversations on a 24-hour basis.

Electronic & Missile Facilities, Inc., of New York will build a central laboratory and office facility for National Aeronautics and Space Administration's Marshall Space Flight Center at Huntsville, Ala. The $4-million contract calls for a nine-story structure containing 227,000 sq. ft., including a ground floor, first floor and seven tower floors. It will house the center's headquarters offices and its Aeroballistics and Research Projects Divisions.

Weber Aircraft Corp., Burbank, Calif., will design, develop, fabricate, test and produce an ejection seat and survival system for USAF's Dyna-Soar manned space glider under a $600,000 subcontract from The Boeing Co. Survival system will include parachute and emergency oxygen supply.

National Research Corp., Cambridge, Mass., will conduct a preliminary study of a cesium propellant feed system for spacecraft ion engines, under the sponsorship of the National Aeronautics and Space Administration's Marshall Space Flight Center. Study, for an undisclosed amount, will investigate properties of cesium, materials for design of the fuel injection system and feed methods for varying flow rates.

Kollsman Instrument Corp., subsidiary of Standard Kollsman Industries of Melrose Park, Ill., has received a $9-million contract from North American Aviation's Autonetics Division for KS-140 Astro Tracker navigation systems to be installed on Hound Dog air-to-surface missiles. Kollsman also has been awarded a $1,900,000 Air Force Aeronautical Systems Division contract for automatic astro compasses. USAF contract is for MD-1 compasses and is in addition to earlier orders for Kollsman navigational equipment which is presently being utilized on B-52 as well as B-58 aircraft.

Pratt & Whitney Aircraft Division of United Aircraft Corp. has established an Advanced Materials Research and Development Laboratory at P&W's North Haven, Conn., plant to develop new materials for future aircraft, space and industrial powerplants. Principal goals will be development of high-strength metals, alloys for service at extreme temperatures and metals for energy conversion devices.

General Motors' Allison Division has received a $1,467,200 contract from Aerojet-General Corp. to develop and produce titanium second-stage rocket engine cases for use with the Minuteman ICBM.

Lockheed Aircraft Corp. has received an additional Army contract of $1,017,076 for the second phase of a program to design, manufacture and test a research aircraft using the jet ejector lift principle.

Thiokol Chemical Corp. will produce packaged liquid propellant rocket engines for Navy's Bullpup missile under a $4,030,782 letter contract.

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Hoffman now offers a new and complete line of specialized test equipment necessary to maintain TACAN accuracy in the field—thus insuring the superior performance built into airborne TACAN equipment. Compact and rugged Hoffman simulators are available as standard off-the-shelf items (federal stock numbers assigned), and at lowest cost. Equipment tests all airborne TACAN models now in use.

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HLI-116A
Peak Power Calibrator

Measures peak output power of TACAN transmitter in kilowatts without use of calibration charts or auxiliary equipment.

HLD-141/144/146
Instrument & Power Panels

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Send for complete data file on Hoffman TACAN test equipment and TACAN air navigational systems.

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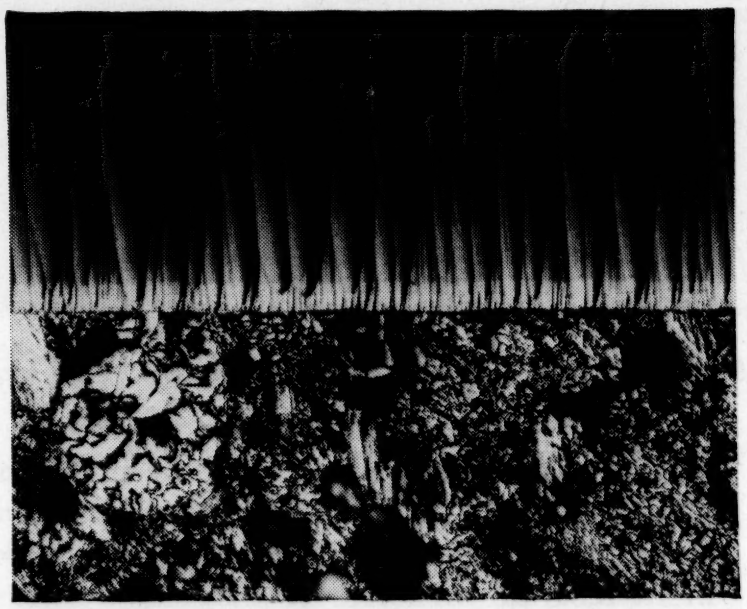
Produced as a coating on commercial graphite, it can also be built up to sufficient thickness for use as free-standing parts. Pyrolytic Graphite is well suited for many space, missile and electronic applications, including leading edges, rocket nozzles, and coatings for nose cones.



Note structural differences between ordinary graphite (bottom) and Pyrolytic Graphite (top). Ordinary graphite has crystals arranged at random with high porosity; pyrolytic crystals have high degree of orientation with no porosity.

For additional information, write: *Specialty Alloys Section, Metallurgical Products Department of General Electric Company, 11107 E. 8 Mile Avenue, Detroit 32, Michigan.*

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Reduction of Ranger Components Studied

By Russell Hawkes

Newport Beach, Calif.—Design concept used in the lunar landing sphere and seismometer payload for NASA Ranger 3, 4, and 5 is to minimize the number of operations which could have a critical effect on the functioning of the payload and telemetry, according to officials of Ford Motor Co.'s Aeronutronic Division, prime contractor for the sphere.

An important effect of this is to sharply reduce the number and weight of components and redundant systems needed to provide equal data with equal reliability. Since the weight is saved in the final unit to be placed intact on the surface of the moon, the retrorocket, spacecraft and all the other vehicle components needed to transport the unit can be smaller and lighter. This makes the Atlas Agena B a feasible launch vehicle and Ranger lunar missions will begin before the end of April, 1962, if there are no important slippages.

The landing capsule is a 25-in. dia. fiber glass covered sphere made of balsa segments glued together with the grain oriented radially. It weighs 98.2 lb. At the core of the landing sphere is the 12-in. dia., 56.3-lb. survival sphere containing the battery-powered seismometer and telemetry transmitter.

The seismometer is a single-axis measuring device consisting of a spring-mounted mass with a variable reluctance electromagnetic pick-up capable of measuring displacements as small as one millionth of an inch. It was developed by the CalTech Department of Seismology which shares with Columbia University the responsibility for the experiment.

The seismometer is so sensitive that it cannot be tested at the Ford plant because of interference from waves breaking on the beach several miles away. To withstand the 2,000-2,500g impact of the lunar landing the suspended mass of the delicate instrument is caged by floating it in a fluid of equal density which is drained automatically after the landing.

Since it is designed to operate under the influence of the lunar gravity which is only 16.5% of earth's gravity, the seismometer is laboratory-tested by tipping it at an angle so that the axial component of motion for the suspended mass is reduced to the lunar equivalent. The instrument is designed to measure short-term seismic disturbances. It has a natural period of oscillation of one second. It will not record so-called tidal disturbances with periods on the order of two weeks. It is expected to record meteorite impacts as well as internal disturbances.

The survival sphere containing the seismometer is floated in a liquid and its center of gravity will be so located that it will erect itself without any sort of actuator. The liquid will be composed of two very dense Freons mixed in a proportion which will give it a density equal to that of the instrument sphere which will, therefore, have neutral buoyancy.

The flotation liquid also distributes the impact load.

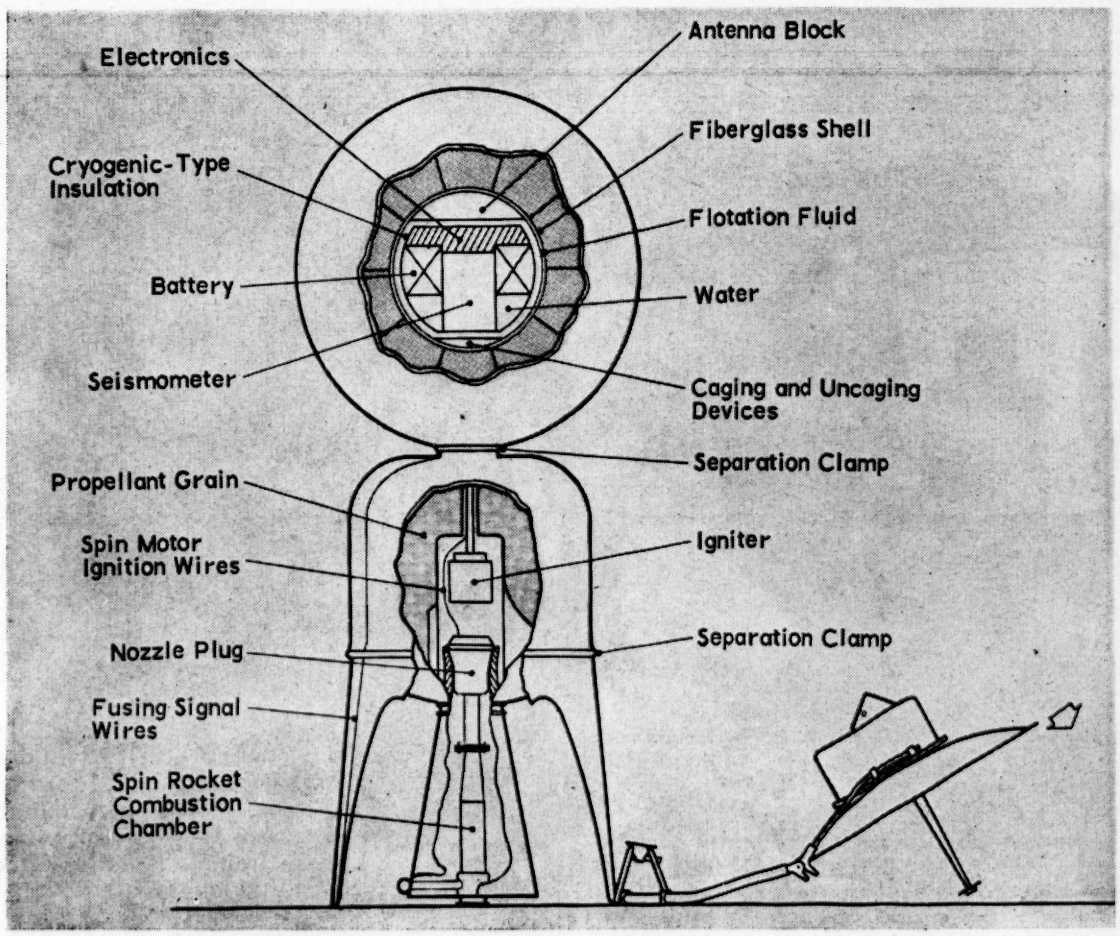
Impact Damage

Since it was designed under a policy of minimizing the number of critical operations, the seismometer will function even if impact damage is greater than anticipated and the inner sphere fails to erect or the flotation fluid fails to drain. It would even operate if the expended retro motor failed to separate. Data transmitted would be degraded but much useful information would still be gained. Project officials claim a fully successful Ranger mission will double the body of information known about the moon.

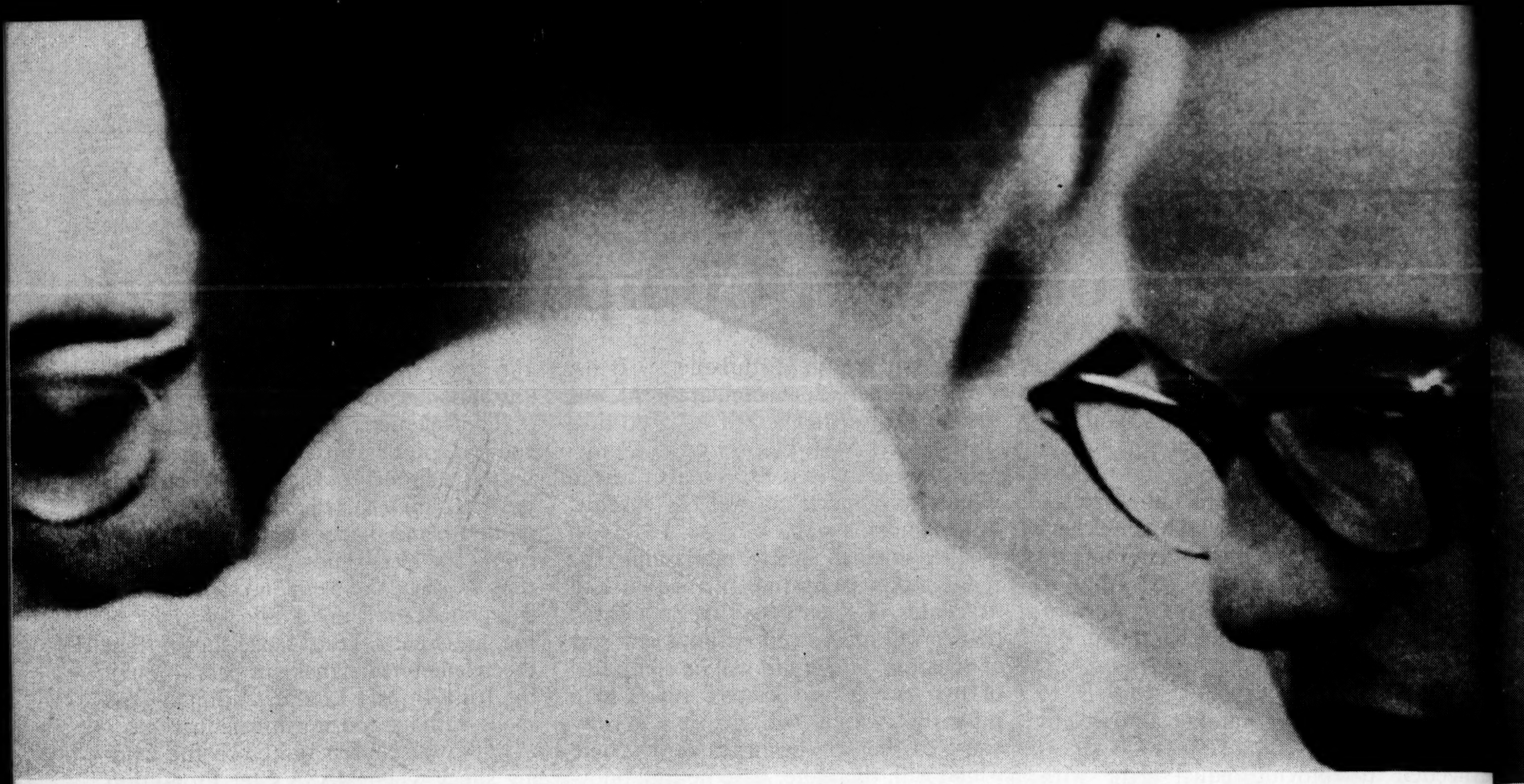
The telemetry transmitter located in the top of the survival sphere uses an omnidirectional crossed-dipole antenna mounted on a balsa base above a copper-ground plane that separates the antenna from the electronics and instrumentation so that there are no other metal components within a line of sight of the antenna. Tests have shown that the telemetered signal can pass through the balsa Impact Limiter and fiber glass shells without too much attenuation.

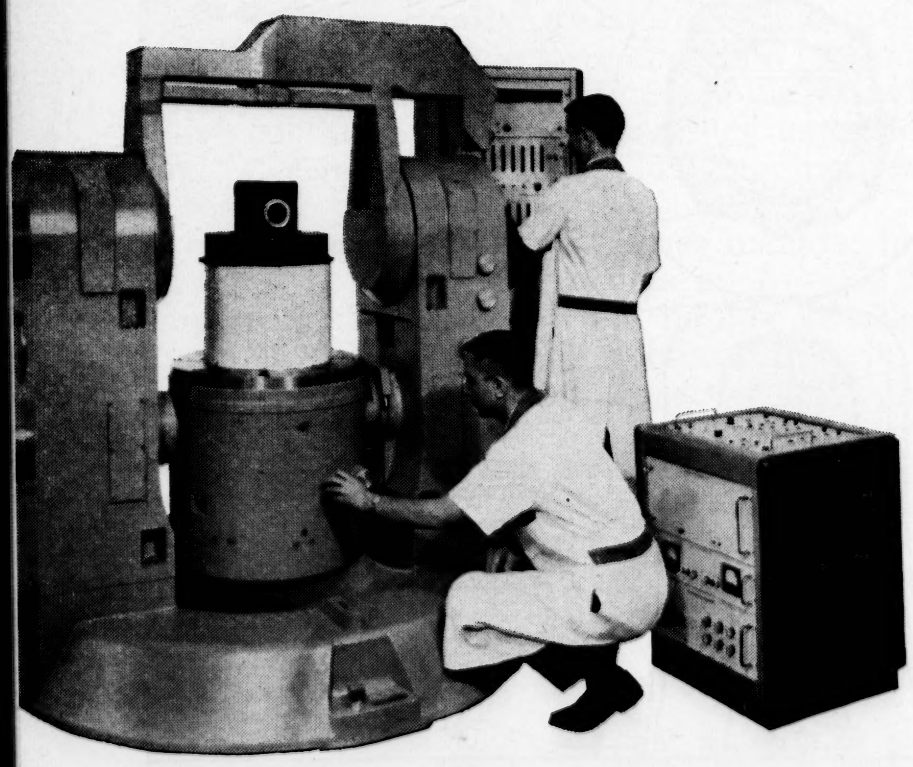
Balsa was chosen to absorb the landing shock when NASA's Jet Propulsion Laboratory experimenters found it to have about three times the impact absorbing power of the next best material. Aeronutronic engineers had been expecting to use a nylon honeycomb crushable Impact Limiter until they heard of the JPL work. Fiber glass-covered balsa Impact Limiter spheres have been fired against targets in the laboratory and they have been observed to return to something approximating their original shape after having been crushed by impact. It retains its impact-absorbing power in a vacuum and the outer fiber glass cover is not to be made air tight.

Lunar impacts simulated in the Aero-



CUTAWAY DRAWING of Ranger lunar capsule shows components of capsule targeted to land on the moon and telemeter scientific data back to earth for a month or longer.





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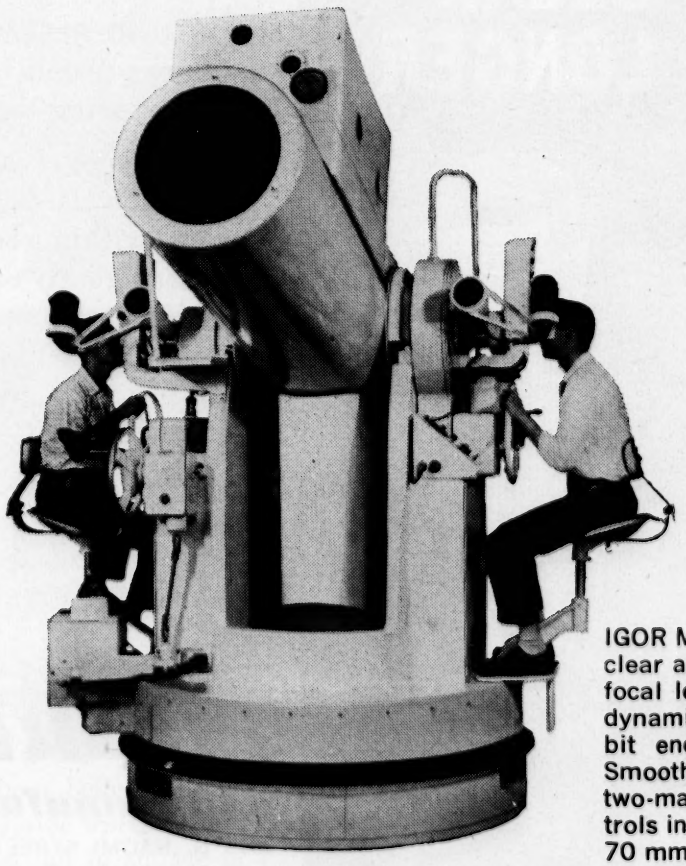

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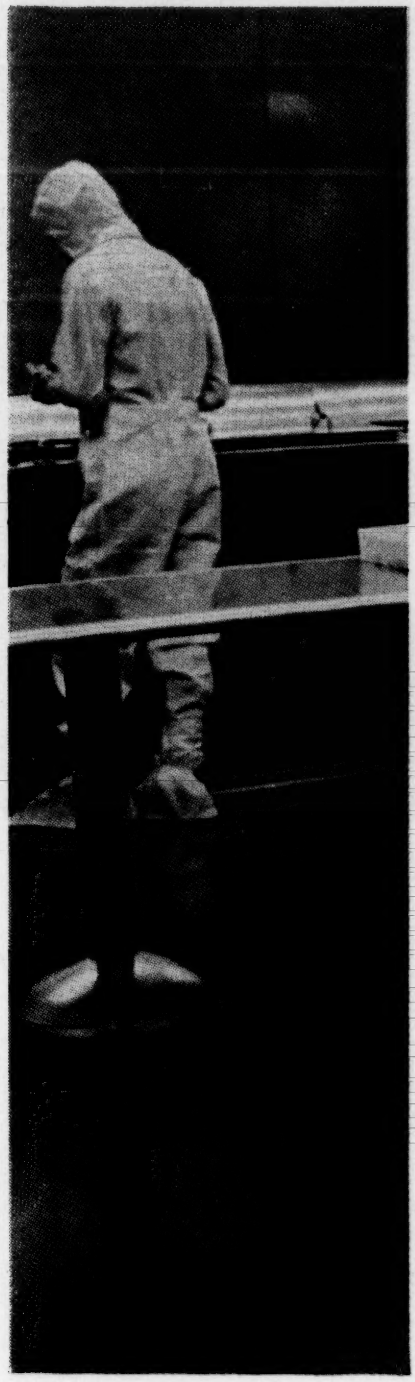

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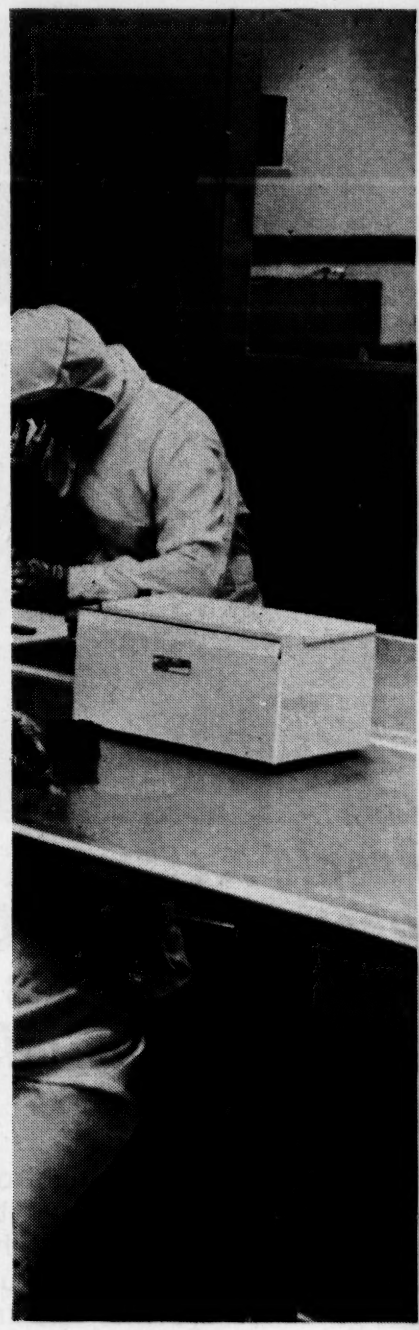

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nutronic Laboratory and in free drops from aircraft indicate that the most damaging landing is a glancing impact rather than a vertical drop to the surface.

Data telemetered from the survival sphere is first converted to a signal which is easier to transmit than the original seismic wave-form. Special adapters will be installed at the three Deep Space Instrumentation Facilities to reconvert the signal to a recognizable seismic trace. The big DSIF receivers are expected to be the only facilities which will be capable of reading out Ranger telemetry.

The Ranger landing sphere and spacecraft will be thoroughly sterilized to prevent biological contamination of the moon. Ford scientists say that controversy on this subject has completely disappeared and the same policy of sterilization has been used by the Russians even for their fly-by missions because of the possibility of an accidental crash on the moon.

The decision to use a balsa Impact Limiter in the landing sphere helps solve the sterilization problem because kiln-dried balsa is naturally sporicidal. The unsterilized Agena B carrier rocket is also likely to be on a lunar transfer orbit, but when the spacecraft separates from the Agena it will be turned 180 deg. and small solid rockets will propel it out of the Ranger trajectory.

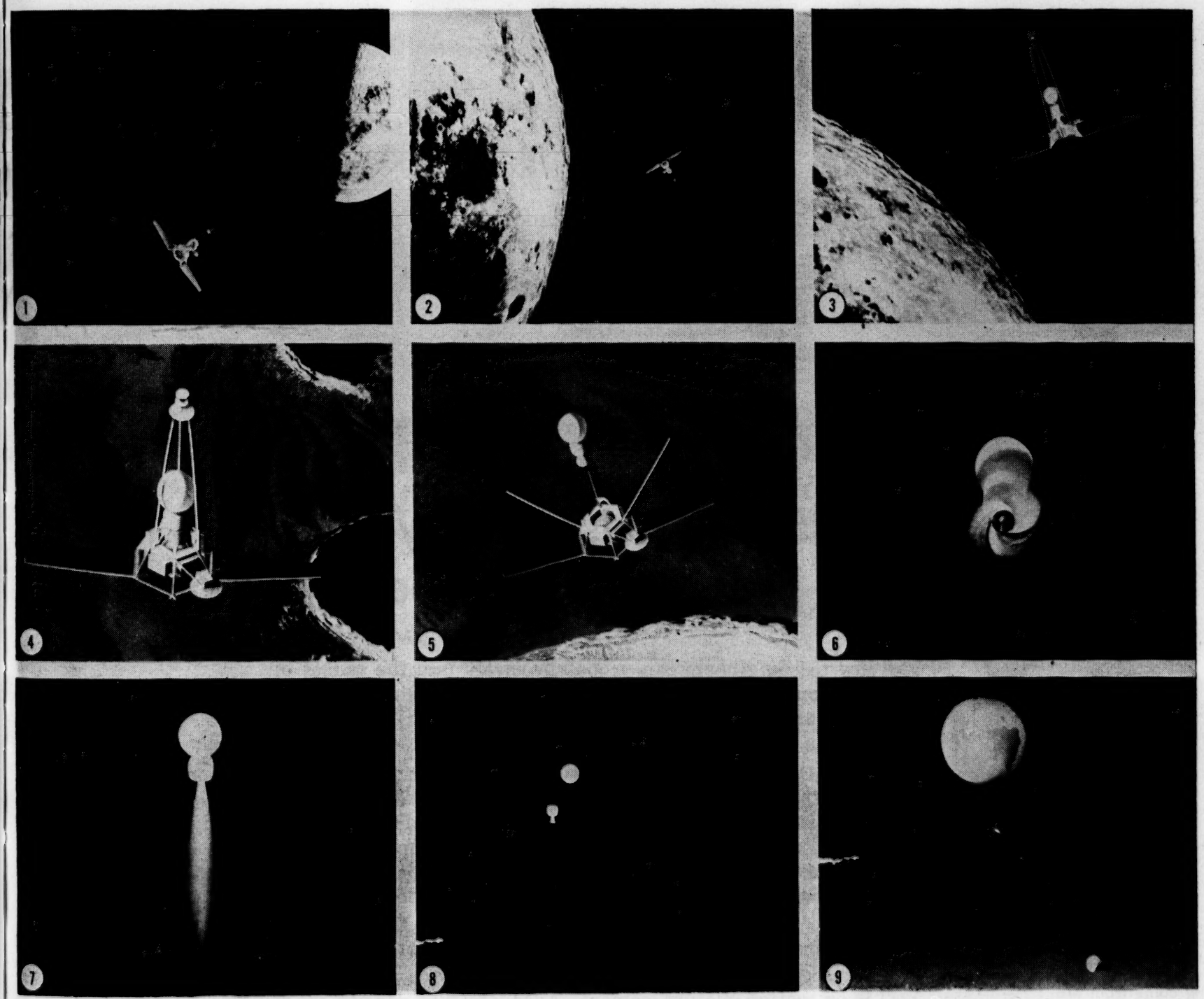
Vacuum Insulation

The temperature in the survival sphere is stabilized by a cryogenic-type vacuum insulation with alternate layers of dacron felt and aluminum foil. There is 3.6 lb. of water ballast which will circulate convectively to transfer battery heat through the sphere. The two silver-zinc batteries are semi-circular in shape to fit the sphere.

The nominal velocity at impact for the landing sphere is 108 fps. or 73 mph., but because of the large errors which are possible and acceptable in the system, Ford scientists prefer to say impact velocity will be "less than 150 mph."

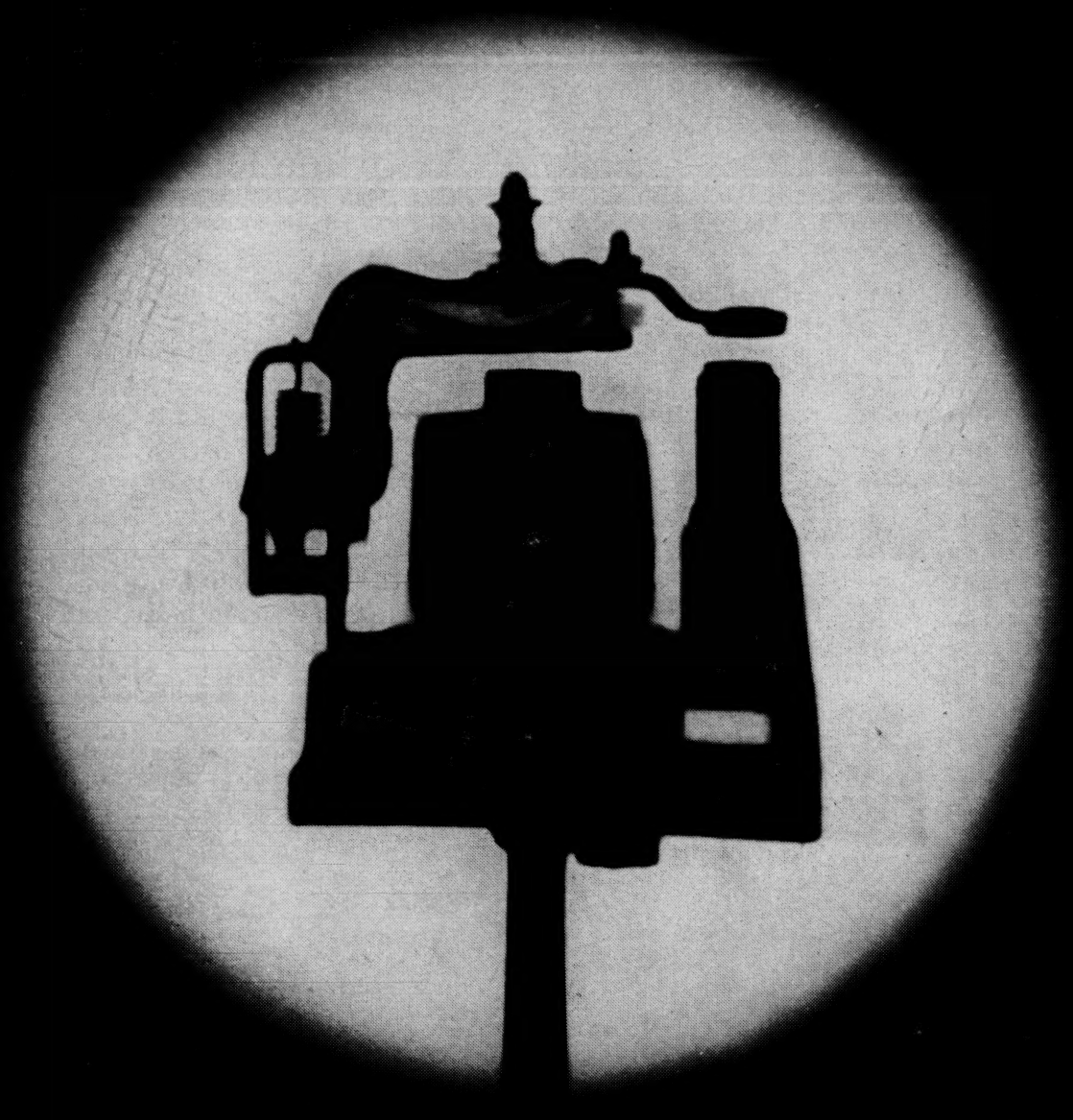
The landing sphere will be decelerated to this speed from its 6,500-mph. approach speed by a high performance solid propellant rocket developed by Hercules Powder Co. especially for the mission. It is reported to have a mass ratio better than 0.90 and the grain is shaped and loaded in such a way that thrust decreases with time to control deceleration as propellant consumption reduces the weight of the vehicle.

The programed sequence of events leading to the lunar landing after separation of the Ranger spacecraft from the Agena B carrier begins with a mid-course maneuver which includes any necessary correction in the transfer orbit and a re-orientation of the spacecraft to face its solar panels toward the sun. Attitude information is supplied by a sun seeker and a moon seeker. Control power is provided by very small jets of compressed nitrogen. Thrust produced by these is so small that a 180-deg. ro-

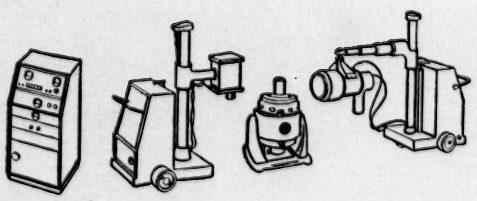


RANGER LUNAR LANDING SEQUENCE. An hour before reaching the moon, a signal from earth will alter spacecraft attitude. About 25 mi. from moon's surface, the spacecraft and capsule will separate. Spin rocket provides stabilization. Retrorocket will cushion impact. Capsule will be ejected from the retrorocket and fall to surface of the moon. Capsule is being built by Ford Motor Co.'s Aeronutronic Division, for NASA/JPL Ranger program.

The important advances in environmental testing come from MB



New MB-Zenith 150 KV pulsed X-ray system takes motion pictures of high speed phenomena



A pioneer and leader in the field of electrodynamic vibration systems, MB continually strives to improve the performance and reliability of vibration, shock and fatigue testing. The important advances in environmental testing come from MB.

MB Electronics has representatives in principal cities throughout the world.

Now test engineers can probe effectively into the causes of vibration and shock failures, or observe dynamic systems, detonation effects and other high speed phenomena occurring within a sealed environment.

The pulsed X-ray system developed by Zenith Radio Research Corp. and marketed by MB Electronics provides an effective means of obtaining X-ray motion pictures of these rapidly moving sealed parts. Typical of the capabilities of the system is the above reproduction of a high speed motion picture of an hermetically sealed relay in operation while being vibrated.

The image obtained with the pulsed X-ray system is more than 2000 times brighter than that obtained with an X-ray fluorescent screen. It is suitable for direct viewing, closed circuit TV or motion picture camera. Adequate film density is obtained through 2″ of aluminum at a distance of 3 feet from the tube.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1060 State Street, New Haven 11, Conn.

tation at mid-course would take a half hour to complete.

Track information is calculated by the on-board guidance computer and transmitted to ground stations for comparison with tracking receiver data. If the track must be corrected, propulsion is supplied by a 50-lb. thrust hydrazine monopropellant rocket which fires at constant thrust for a time controlled by the magnitude of the correction. If necessary, three or four restarts will be possible for multiple corrections.

About 65 min. before impact of the unbraked spacecraft, a terminal maneuver to point the axis of the spacecraft at the moon will be initiated on command from a ground station. It is expected that all later events will be started automatically by the programmer on board, though some can be initiated on command.

Forty minutes before unbraked impact at an altitude of 4,900 kilometers above the lunar surface, antennas are deployed. As the spacecraft falls, data will be telemetered from two experiment packages which will be obliterated in the crash of the unbraked spacecraft. One of these is a gamma ray spectrometer and the other is a videcon television camera.

At an altitude of 524,000 ft. and 60.6 sec. before the crash of the spacecraft, the radar altimeter will be turned on. It will be operating at 397,000 ft. and 45.6 sec. before impact. When the altimeter indicates an altitude of 70,200 ft., it will send out a "go" signal to separate the landing capsule from the spacecraft. The torques produced by the separation are expected to overcome the small nitrogen jet attitude stabilizers and upset the spacecraft so that the videcon and the gamma spectrometer will not bear on the moon but will keep operating until they are destroyed by impact.

A tenth of a second after separation, the spin rocket mounted in the expansion cone of the landing capsule retrorocket will spin-stabilize the capsule. Two seconds from separation, the retro motor will fire and the spin rocket will be ejected from the cone along with the nozzle plug. The retro motor will burn for 10 sec. as the vehicle falls from 52,700 ft. to an estimated 1,090 ft. At burnout the retrorocket will have brought the capsule to a dead stop.

From the burnout altitude, it is to fall free to the surface of the moon, accelerating at 5.31 fps. per second due to the lunar gravity. Impact is calculated to be 23.9 sec. after the crash of the spacecraft and at a velocity of 108 fps. How precisely the actual flights of Rangers 3, 4, and 5 follow the planned sequence of events, velocities and altitudes will depend largely on whether the capsule's horizontal component of motion is excessive.

Ranger Weight Summary

	Weight (Pounds)
A. Retrorocket payload	
1. Survival sphere	
Electronics, antenna, batteries, wiring	23.1
Structure, insulation, devices	14.4
Water	3.6
Seismometer	7.8
Flotation fluid and outer shell	7.4
Survival sphere total	56.3
2. Impact limiter, cover and rocket motor/sphere interconnection	39.3
3. Vibration damper	1.2
4. Control timer, batteries, wiring	1.4
Total retrorocket payload	98.2
B. Motors	
1. Retrorocket motor and igniter	208.5
2. Spin motor, igniter and attachment	2.2
Total separate weight	308.9
C. Bus-mounted equipment	
1. Altimeter and antenna	6.5
2. Altimeter support and deployment	2.0
3. Motor support structure and separation	3.6
4. Bus interface J-box and connectors	1.0
5. Retrorocket heat shield	3.0
Total lunar capsule	325.0

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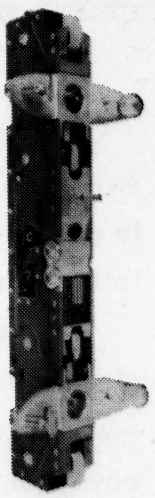
Developed for the U. S. Air Force Special Weapons Center for use on several Fighter-bombers, Bombers and V/STOL aircraft, this RPI rack features *adjustable* ejection force and all required safety devices. It is easily attached to the aircraft and provides both 14" and 30" hook spacing.



FOR TECHNICAL DATA on the RPI Universal Ejector Rack write for Bulletin #1500.

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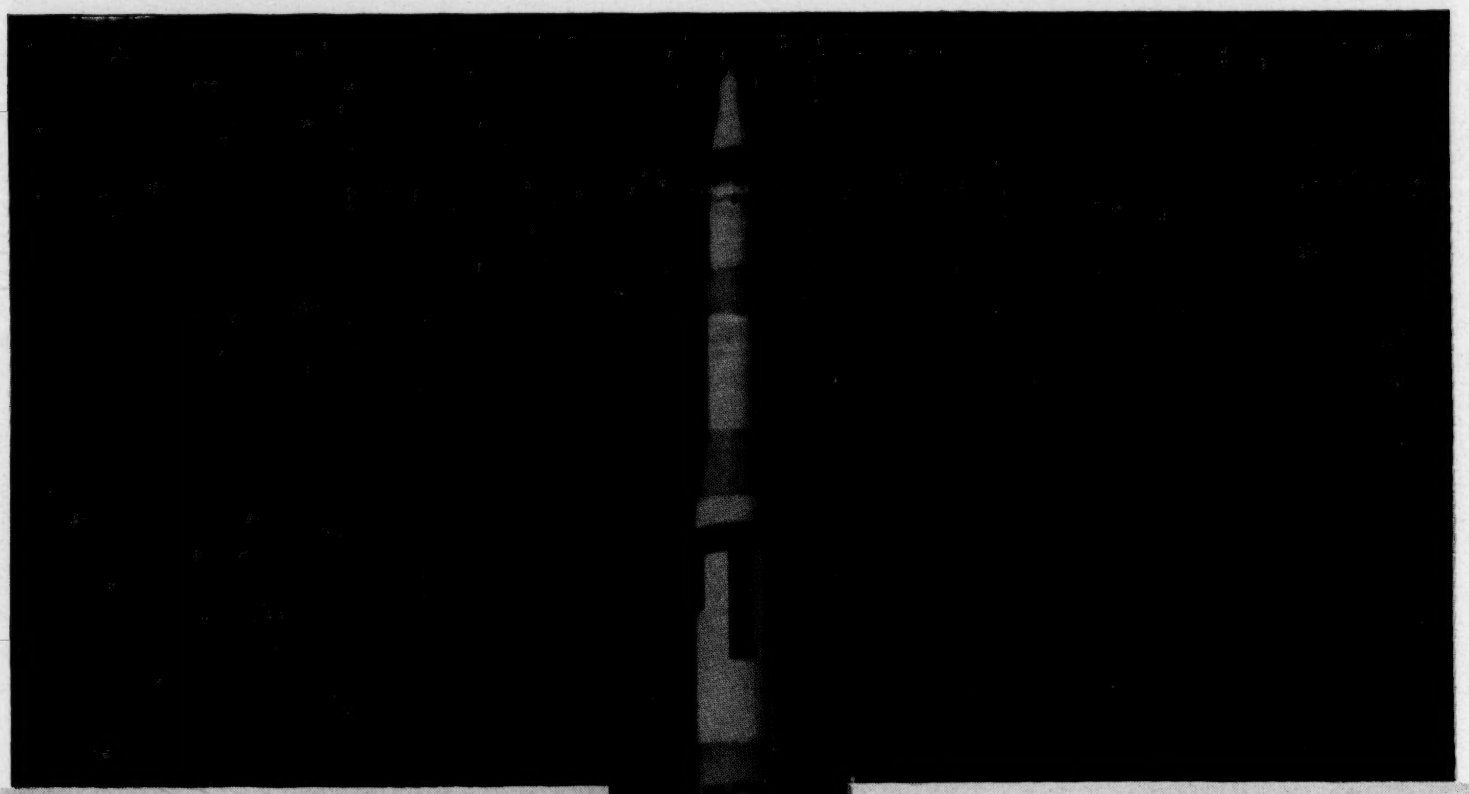

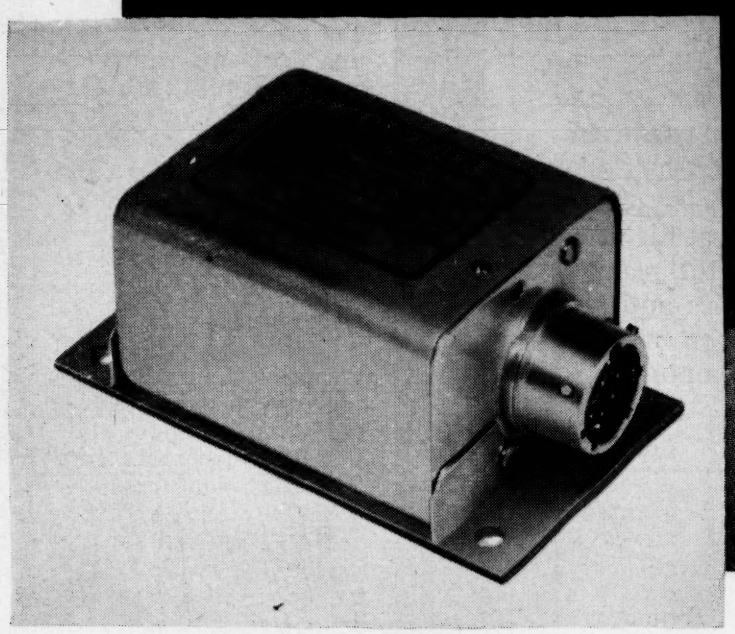

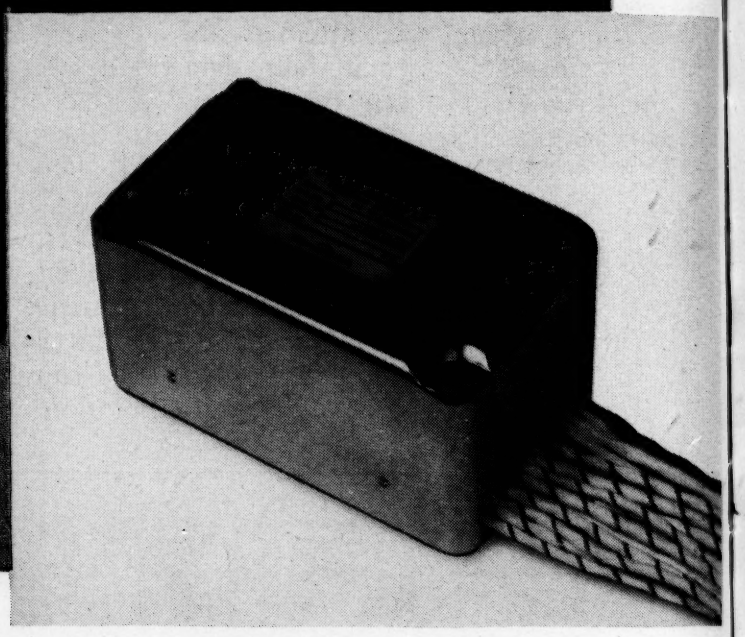

off-the-shelf telemetry is dead

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For more than 10 years, Avien engineers have been working with manufacturers to insure the best design for the particular telemetering application—tailoring solid experience to fit the need. It's time you benefited from this approach. Write today for free information on how Avien's telemetering capabilities can work for you.

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ACCESS Shows Newest Data Link Ideas

By Philip J. Klass

Washington – Aircraft Communication Electronic Signaling System (ACCESS), a new data link recently proposed to the Federal Aviation Agency by the team of Motorola and General Precision, Inc., reflects many changes in thinking on data link requirements that have resulted from two years of FAA testing on an experimental equipment.

When FAA purchased the experimental AGACS (Air-Ground Communications System) from Radio Corp. of America three years ago (AW July 28, 1958, p. 70), one of the major objectives was to use it to establish the operational and technical requirements for data link.

Out of these tests at FAA's National Aviation Facilities Experimental Center at Atlantic City, and studies by the Air Transport Assn., have come the following conclusions:

• **Use of push buttons** for communications between pilot and controller is not as easy or natural as conventional voice communications for most functions.

• **Flexible format message capability** is needed for transmitting to aircraft such things as long flight clearances and weather advisory information, with provision for providing pilot with printed ("hard") copy of such messages for future reference. (Original RCA system lacked these capabilities.)

• **Data and voice** should be transmitted on a single radio channel (multiplexed) to enable existing airborne radio/transmitter to handle both services and to simplify pilot tuning procedures.

The characteristics of the ACCESS system generally reflect current thinking in FAA and ATA as a result of considerable time which Motorola/General Precision engineers spent in discussions with FAA and ATA engineers before preparing their proposal.

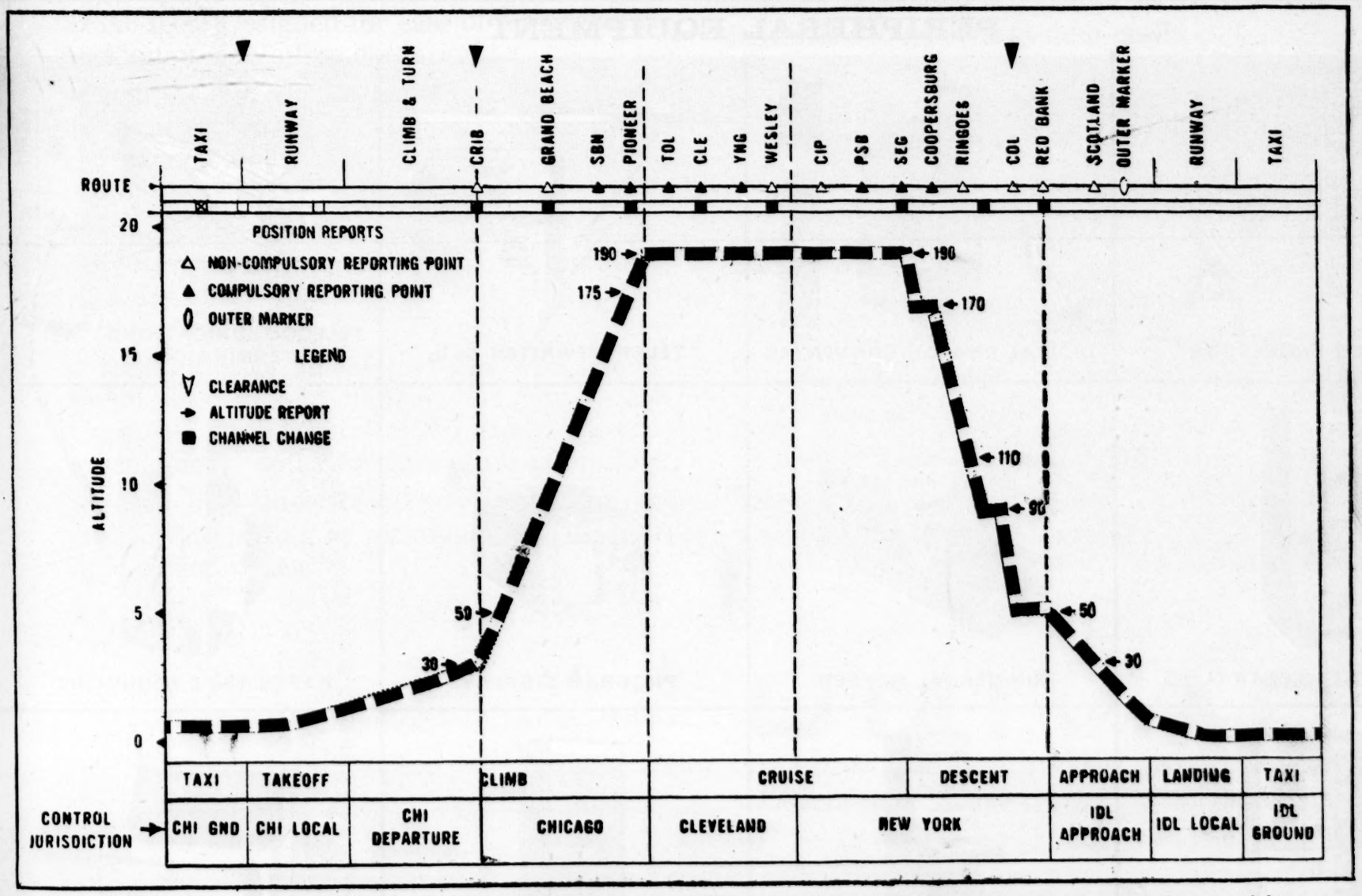
In the proposed new system, the only pilot control device in the cockpit would be a small insertion-display unit containing four push buttons, two of which also contain lamps that illuminate their respective push buttons under certain conditions. The function of these push buttons is as follows:

• **Fix report:** When pilot passes over assigned fix, he depresses this button which automatically transmits data link message, when aircraft is next interrogated by the ground data link advising traffic controller and/or traffic computer of airplane identity and its time over the fix.

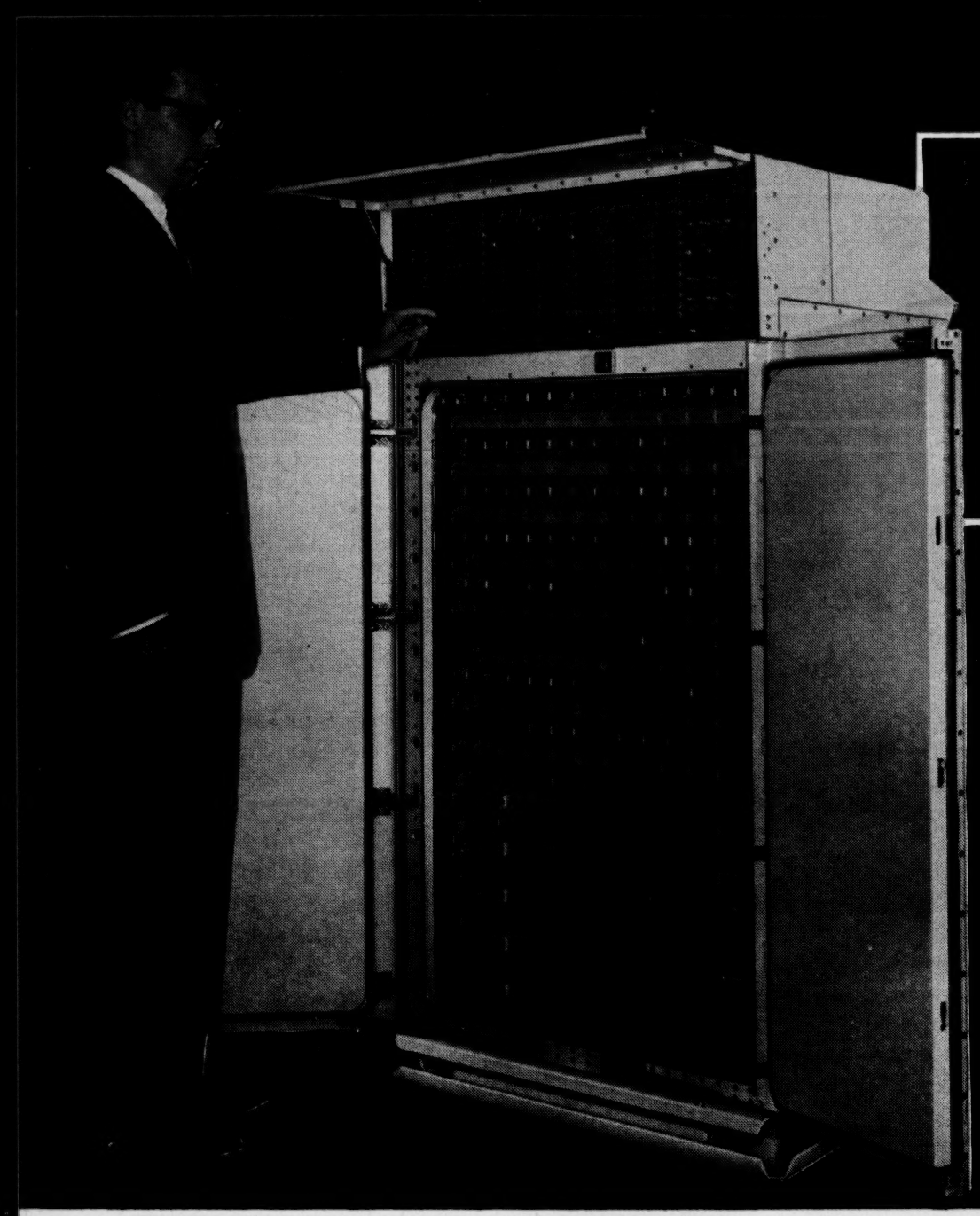
• **Acknowledge:** When the controller or traffic control computer transmits a message to an aircraft that requires pilot concurrence, the ground-to-aircraft message includes such a request which automatically lights the bulb behind the "acknowledge" button on the pilot's insertion-display unit. To indicate receipt of message and concurrence, the pilot pushes the button.

• **Audio reset:** If the pilot does not wish to monitor controller voice conversations with other aircraft, he pushes the "audio reset" button which silences his receiver until such time as controller initiates a call to his aircraft.

• **Pilot entry:** When the pilot wants to talk by voice with the controller, he



SAMPLE FLIGHT PROFILE from Chicago to New York shows nine different control jurisdictions and eight en route changes of frequency under present system. Total voice messages under present system is 111. ACCESS would cut voice messages by more than 50%; would reduce total transmission time 47.5%. Breakdown of communication systems by message type and time is shown on chart on p. 105.



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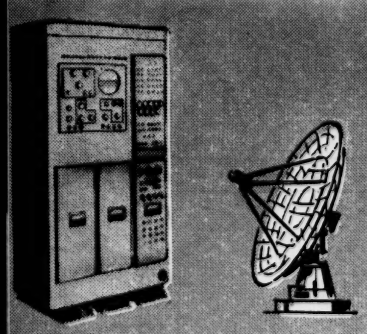
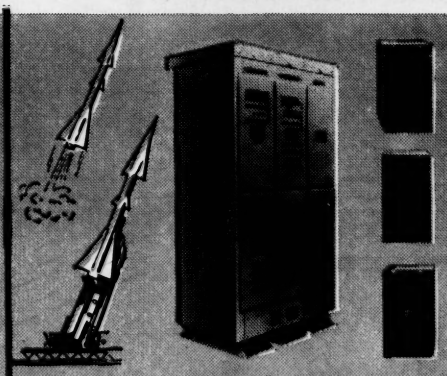
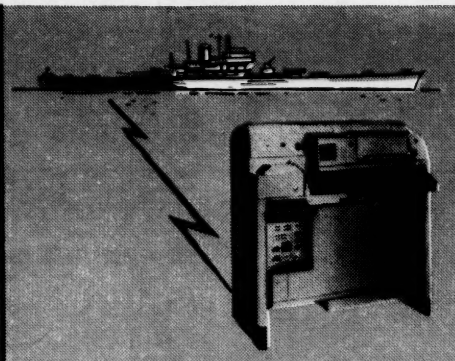


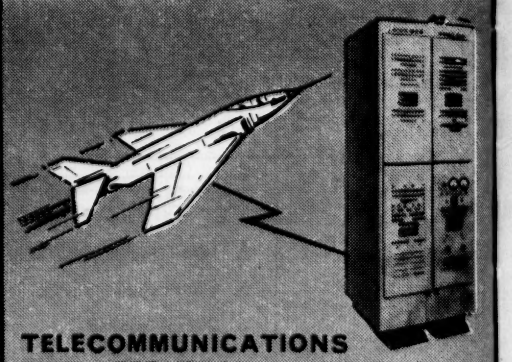
VIDEO PROCESSOR



DIGITAL-ANALOG CONVERTER

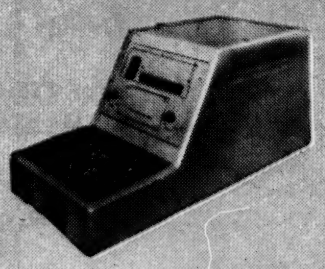


TELETYPEWRITER SET

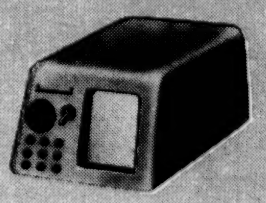


TELECOMMUNICATIONS TERMINAL

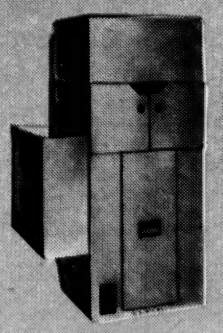
KEYSET CENTRAL



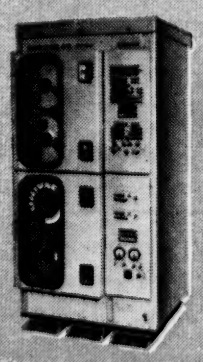
UNIVERSAL KEYSET



PROGRAM DISPLAY

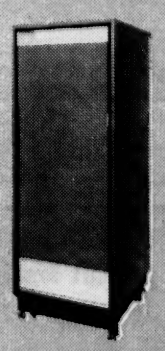


PAPER TAPE EQUIPMENT

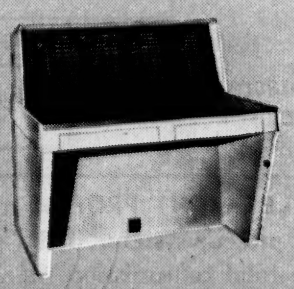


MAGNETIC TAPE SYSTEM

SYSTEM MONITORING PANEL



FORMAT CONTROL UNIT



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pushes the "pilot entry" button which causes a display on the controller console to indicate the identity of the aircraft that wishes to communicate.

Voice Communications

When the controller is free to talk to this aircraft, he pushes buttons which transmit data link messages to the specific aircraft, raising the volume level of its receiver and flashing a light on the pilot insertion-display unit. The pilot then communicates by voice in a conventional manner. This provision eliminates the need for the pilot to monitor other conversations while waiting for an opening.

In the event of an emergency, the pilot always can break into existing communications as he would today.

For transmitting weather and clearance messages to the cockpit, ACCESS envisions use of a small airborne teleprinter which would type out messages for permanent pilot reference (AW Aug. 7, p. 41). Such a device is under development by Mite Corp., Paramus, N. J., under FAA sponsorship. The tiny airborne teleprinter, measuring only 3½ x 4¾ x 8½ in. deep, prints 26 characters per line on wide adding-machine roll paper. Design objective calls for print speeds up to 600 characters per minute.

Prototype model is scheduled for delivery early in 1962 for FAA evaluation. In production quantities, the airborne teleprinter is expected to sell for $500 to $1,000, a Mite Corp. spokesman estimates.

The message transmitted via data link may be weather data stored in a computer memory drum, prestored change-of-altitude commands selected by the controller, or messages composed by the controller using a conventional teletypewriter keyboard.

Message Selectivity

Such extended messages can be addressed to one or more specific aircraft, or to all aircraft under the jurisdiction of the controller, at his choice. Where acknowledgement is desired, this request is tagged onto the data link message as previously described.

An add-on type feature of ACCESS is its capability of automatic reporting of airplane altitude, bearing and distance to a Vortac station, upon request from the ground, without requiring any action by the pilot. Information on airplane altitude, Vortac bearing and distance would be obtained directly from digital pick-offs in existing sensing/indicating instruments.

Another optional feature of ACCESS is its ability to provide automatic ground-controlled switching functions aboard individual aircraft. For example, when an airplane is leaving one controller's sector and must change to a new radio frequency, this could be accomplished directly from the ground without bothering the pilot. Similarly, the airplane radar beacon transponder could be automatically switched to another replay code without action by the pilot.

For smaller aircraft, Motorola and General Precision propose a minimum airborne digital equipment (MADE), which would provide only the fix report, acknowledge and pilot entry features. Such a MADE system is expected to sell for $1,000 or less, a company spokesman says.

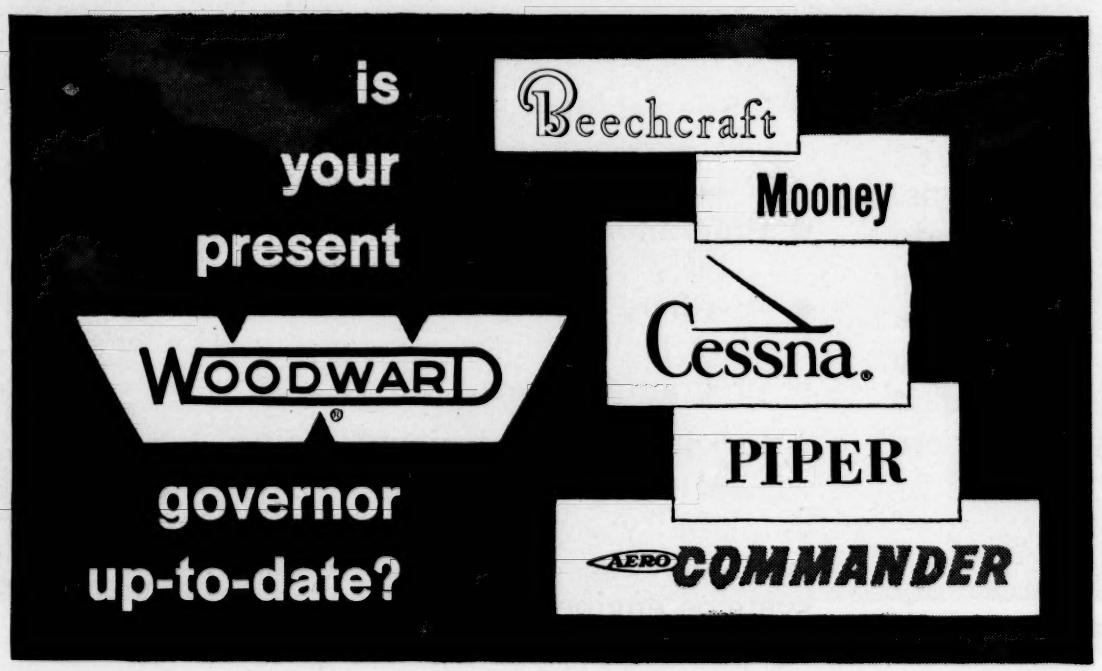
Aircraft that need and can afford the small airborne teleprinter could add the device on an optional basis. Airliners and large corporate aircraft might go all the way and install the automatic position reporting and switching equipment.

For operators who may need extensive weather advisory data, high-speed airborne teleprinters and buffer storage units could be added.

Technical Details

Here are some of the basic technical details of the proposed ACCESS system:

• **Modulation:** Phase-shift-keying (PSK) in which phase of an audio tone is shifted 90 deg. to provide distinguish-



S-106

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ing "mark" and "space" information. Selection of PSK makes it possible to use existing airborne radio equipment without modification, Motorola says.

• **Code:** Fieldata code, expected to become a military standard, makes proposed system compatible with military needs and systems. The Fieldata code employs eight bits per character and includes parity check features.

• **Bit rate:** Present plan calls for maximum bit rate of 1,200 per sec., with slower rates of 600, 300, 150 and 75 per sec. available when required by low-quality landlines between control center and radio transmitter. For long-distance data link service using high frequency radio channels, a bit rate of 50 per sec. would be employed.

• **Message format:** Variable length messages containing three synchronizing characters, followed by four aircraft address (identity) characters and one indicating start of the message. The message itself, containing up to 250 characters, is terminated by an end-of-message character. Total time to transmit a 250-character message would be approximately two seconds.

In operation the ACCESS system would function as follows: A roll-call of aircraft estimated to be approaching a fix point based on their flight plans would be initiated automatically by traffic control computer. Each of the aircraft interrogated would reply giving the airplane identity and an indication of whether the pilot has depressed his fix report button since the last interrogation. When such indication is received, the computer flight plan would be automatically updated and the aircraft would be removed from roll-call until the time for it to pass another fix point.

Approximately one-third of a second is required to interrogate each aircraft and receive its reply, which may also indicate pilot request for voice contact, during roll-call. The roll-call is repeated every 10 sec. Normally there would be only one or two aircraft involved.

For other aircraft under a controller's jurisdiction, which are not approaching a fix point, the system would transmit periodic "all-call" interrogations which, in effect, ask if any of them wish to talk by voice to the controller. For those aircraft whose pilots have pushed the pilot-entry button since the last all-call interrogation, a reply will be transmitted back to the controller's console indicating which aircraft seek voice contact.

Entry Response

This pilot entry response is transmitted back in one of seven randomly selected time slots to minimize the likelihood of interference in the event that two or more aircraft on a single radio channel request voice contact during the same all-call interrogation. If interference does occur despite this provision, some of the responses will not get through to the ground until the next all-call action.

Although the use of time-sharing (time-division multiplex) for voice and data on a single radio frequency eases airborne equipment and pilot tuning requirements, it does mean that any voice transmission may interrupt the flow of data.

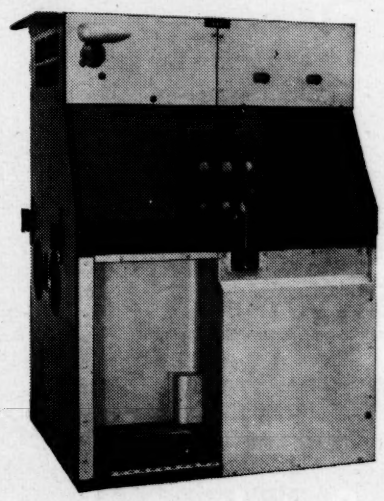
If the ground transmitter is sending out a roll-call or all-call message at the instant the controller presses his microphone button, there may be a delay of perhaps a second until the data transmission is completed and he can take over the ground transmitter for voice.

If an aircraft voice transmission should occur during a data transmission, the latter will be interrupted but will be repeated again 10 sec. later. Such interruptions can introduce small errors into fix report times, but these are not expected to be significant.

The number of aircraft voice transmission interruptions will depend in part upon the percentage of aircraft that are equipped with ACCESS since the data link is expected to cut the need for voice communications.

The system design concept is such that ACCESS can begin to reduce voice

Radar Console



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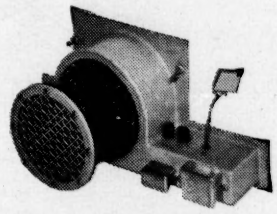

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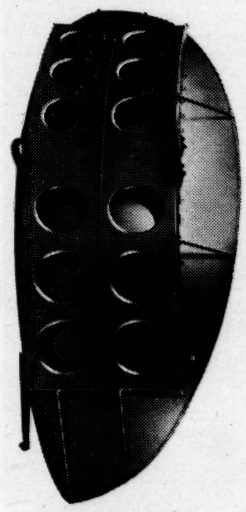
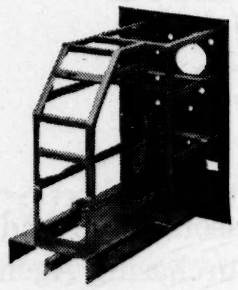
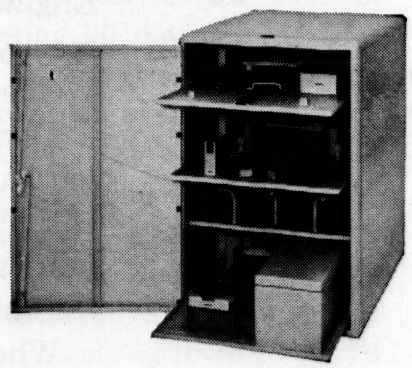


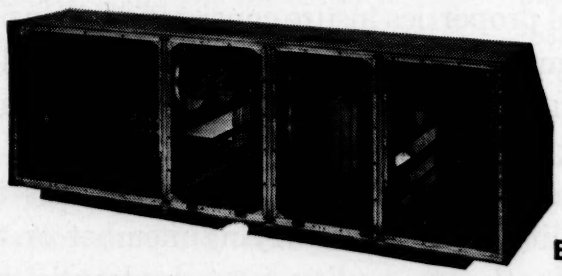
Radar Reflector



Electronic Frame

Storage Cabinet





Electronic Rack

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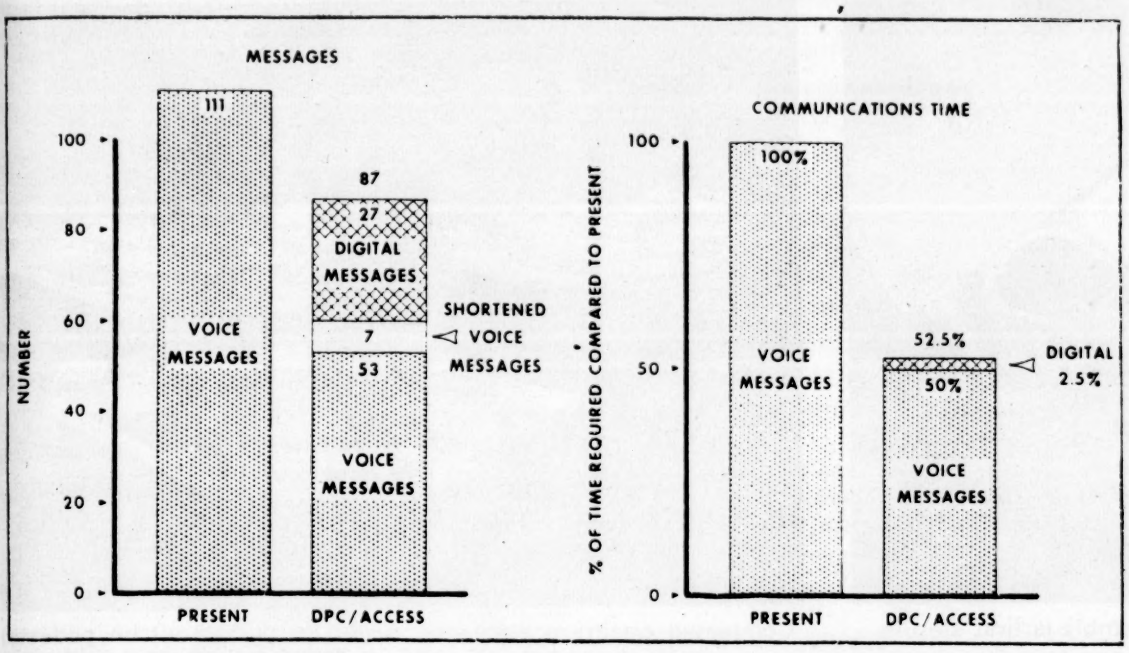


GRAPHS DEPICT DECLINE in voice messages and total transmission time which could be expected after introduction of ACCESS data link system. Messages during flight from Chicago to New York would decline from 111 to 87.

traffic as soon as even a few aircraft are equipped, according to Evan Ragland, project manager for Motorola's ACCESS project.

In one typical flight profile studied by Motorola/GPI, involving a flight from Chicago to New York International Airport, the use of ACCESS and traffic control computers could cut channel time use by nearly half, while reducing the number of voice messages from 111 to 60, according to Ragland.

Motorola and GPI have proposed an 18-month program to FAA under which the two companies would develop and deliver 10 minimum airborne digital units, plus associated airborne page printers and instruments for automatic position reporting. Additionally, equipment required for use by the controller and to simulate the operation of ACCESS from a traffic control computer would be provided. Cost of the program is reported to be approximately $2½ million.

Whether FAA decides to proceed with this or other data link developments will depend upon the recommendations of the forthcoming Project Beacon task force report and action subsequently taken by FAA Administrator Najeeb Halaby.

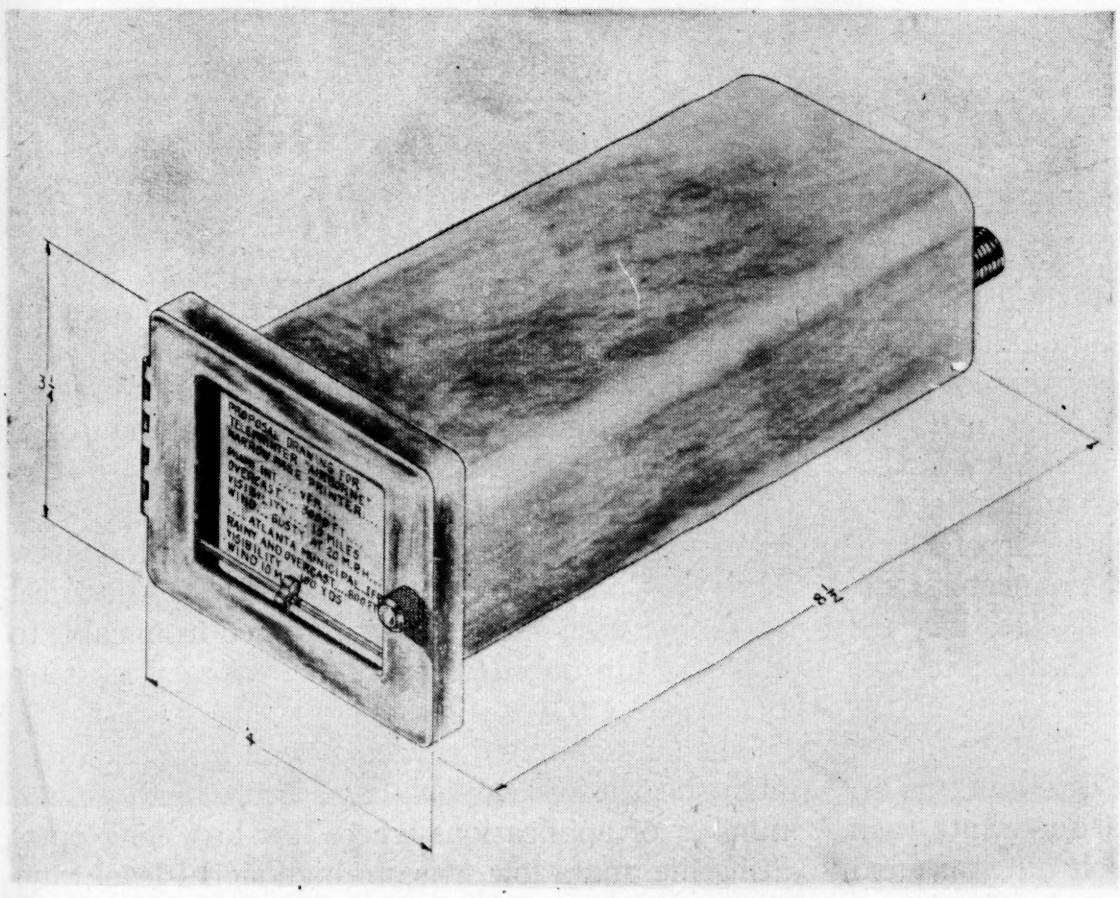
The Project Beacon report is expected to recommend use of airborne radar beacons for automatic altitude reporting, a function which also can be performed by ACCESS and other types of data link.

It is generally agreed that a major advantage of data link is realized when it is used to provide a direct data input to digital computers and output link for relaying computer stored information to aircraft where human controller intervention is not required.

At the time that Motorola and General Precision joined forces to make the ACCESS study and subsequent proposals, the semi-automatic traffic control system which the latter had developed for FAA was expected to be the cornerstone of the future traffic control system. Motorola was to be the ACCESS prime contractor, with responsibility for the over-all system, while General Precision was to handle problems involved in integrating the data link with the controller consoles and computer.

Advance information available on the Project Beacon report indicates that it will recommend a major change in philosophy in which radar and radar scopes will form the primary reference for traffic scheduling and conflict prediction.

The specific recommendations of the Project Beacon report on the role of computers, and the degree to which these concepts are accepted by FAA Administrator Halaby, may largely determine the future of data link developments sponsored by the agency.

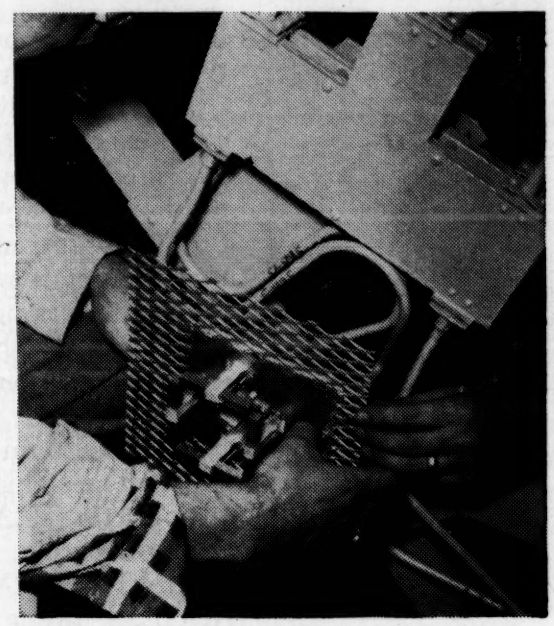


MINIATURE AIRBORNE TELEPRINTER, capable of providing pilot with a permanent copy of flight clearances and weather data, is being developed by Mite Corp. Device can fit into instrument panel and print 600 characters per minute.

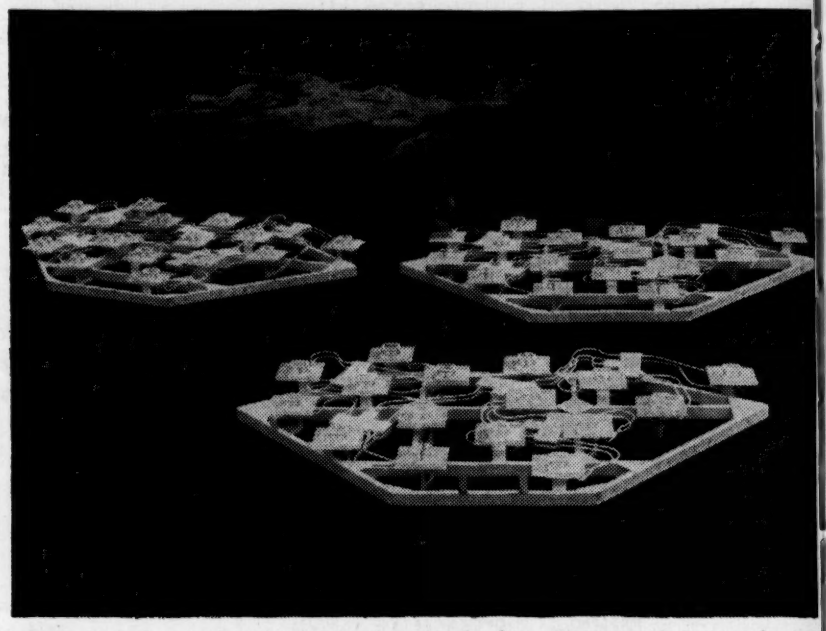
FILTER CENTER

▶ **Lightweight Inertial Navigators for Berlin Crisis**—Litton Systems will make lightweight inertial navigators for the Air Force under a crash program to equip Military Air Transport Service, and possibly commercial aircraft operating in the West Berlin air corridors with navigation aids that cannot be jammed (AW Oct. 2, p. 25).

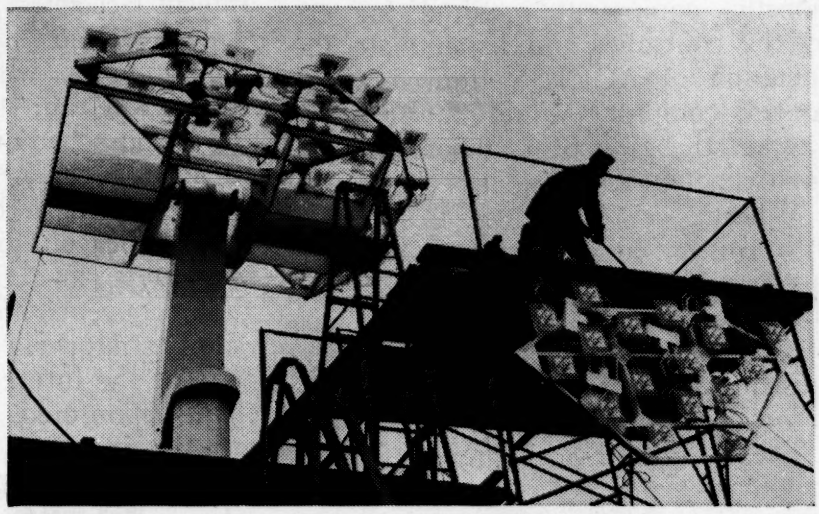
▶ **Bioastronautic Instruments Marketed**—Astra Technical Instrument Corp., Culver City, Calif., will produce and market a line of Boeing Co.-developed biological telemetry and medical gear for airborne and laboratory use under an exclusive licensing agreement with Boeing Associated Products (AW Jan. 16, p. 97). Among items Astra will sell are miniaturized eight-channel (plus one voice channel) belt or vest-mounted personal telemetry system (commutator, transmitter and antenna) which has demonstrated one-mile transmission range, electro-cardiograph electrodes and amplifier, rate of respiration device that straps about subject's chest, thermister temperature-measuring device with amplifier, and a non-airborne oxygen consumption meter.



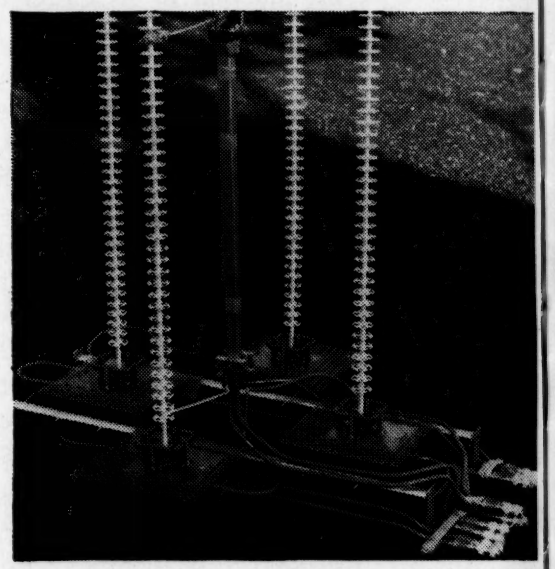
Individual unit assembly is first step in construction of antenna. Here four dipole antennas mounted on ground screen are being connected to one end of Foamflex feed lines. Special Phelps Dodge connectors are used to link the lines to the dipoles and four-way power dividers.



Completed quadrant elements, ready for placement on pedestal mount. Each quadrant is pre-assembled in exactly the same manner.



Completed quadrant elements are raised to platform for placing into position on pedestal mount.



An example of a center element unit that can be inserted into the Avien-Bogner array. This element forms a separate unit that can also be used as a portable ultra high frequency antenna.

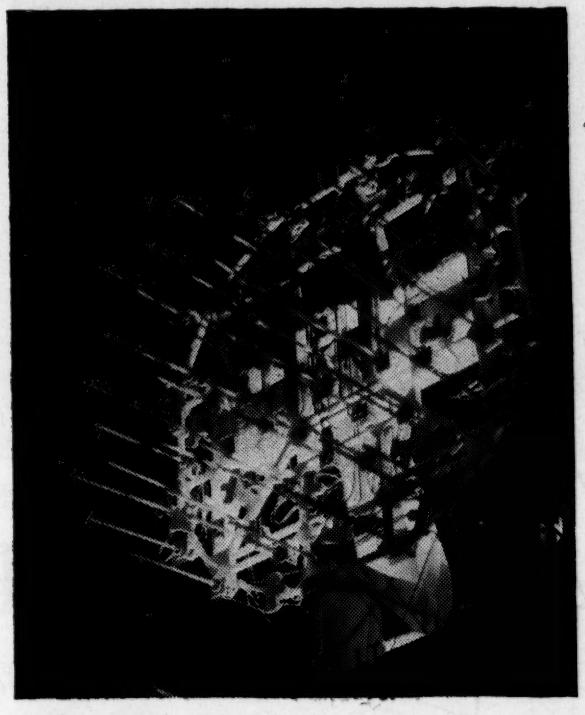
Foamflex® Coaxial Cable helps put and keep this advanced antenna system on the track!

A feed network of $\frac{3}{8}''$, 50 ohm Foamflex coaxial cable is a critical part of the fully automatic Avien-Bogner acquisition and tracking antenna that represents an advance in the state of the antenna art. The efficient operation of this sensitive antenna is greatly increased by the low loss, high phase stability and electrical uniformity of its weatherproof Foamflex feed line assemblies. Special connectors, designed and fabricated by Phelps Dodge, link the Foamflex lines to double-tuned, strip-line, four-way power dividers in each quadrant element of the antenna.

Designed for Edwards Air Force Base, this modular array is assembled from identical quadrants, each equipped with power dividers, dipole antennas and cigar elements. In contrast to the heavier, fixed-type paraboloids, the lighter, smaller Avien-Bogner model costs less, yet has high acquisition capability for telemetry information through the use of three automatic tracking modes. Quadrant elements may easily be replaced when changes are desired in frequency bands, due to the simple design and construction of this antenna.

The feed system was planned, fabricated, calibrated and installed by A-T Electronics, New Haven, Conn. Accurate uniformity of electrical length for each cable was maintained from cable to cable within one degree at 2200 megacycles after bending.

The outstanding qualities of semi-flexible, aluminum-sheathed Foamflex have been proved in a number of applications where low loss, long operating life and a low noise to high signal level ratio are essential. If your specifications call for a coaxial cable of the highest efficiency, we recommend you investigate the capabilities of Foamflex.



Self-tracking Avien-Bogner acquisition array has capability to telemeter data from vehicles traveling in the far reaches of space.

Center element unit is connected to the junction box of the Avien-Bogner antenna.

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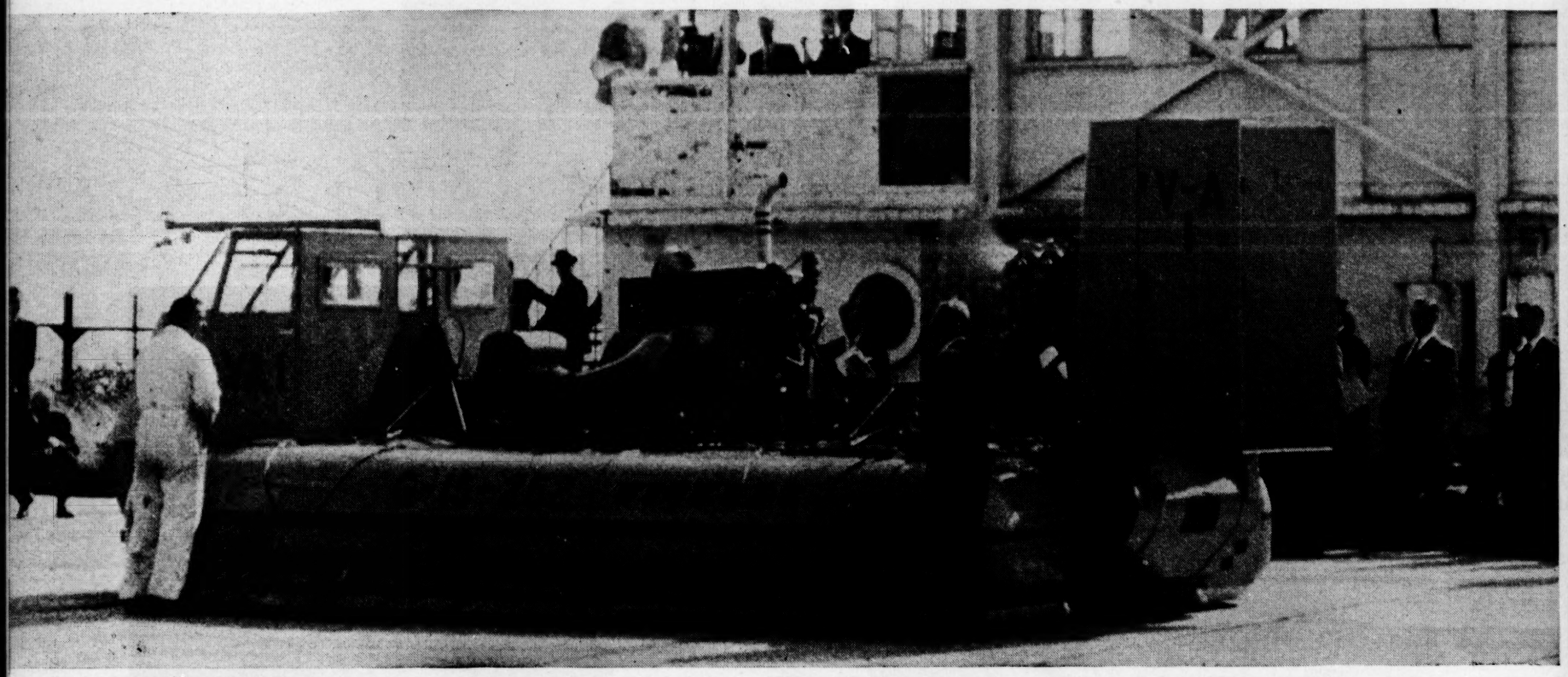


VICKERS-ARMSTRONGS VA-1 hovercraft research vehicle readied for demonstration run. Control problems at 30-kt. are being analyzed.

Advanced 24-Passenger Hovercraft Under

By Herbert J. Coleman

South Marston—Vickers-Armstrongs (South Marston), Ltd., is increasing its concentration on development of commercial hovercraft vehicles and is aiming at "solid business" within five years, in a world market.

Company now is deeply involved in flight testing and follow-on research, using its VA-1 vehicle (AW Sept. 4, p. 39) on both South Marston runways and grass, and for water runs at Southampton, about 50 mi. distant.

In addition, the company is well into construction of a VA-3 24-passenger hovercraft, and is starting to build a VA-2 which will carry four or five passengers and will mainly be used for world demonstrations.

The VA-3, for which no firm price has yet been worked out, will be powered by four Blackburn Turmo 603 turbine engines, two buried to turn lift fans which provide the air cushion, and two mounted externally at the aft end for propulsion.

Follow-on versions, still much in the design stage, are a VA-4, weighing about 100 tons, and a VA-5, of about 225 tons. Vickers' hovercraft range is in addition to these other British developments in the field:

• **Westland Aircraft's** Saunders-Roe Division, in association with Hovercraft Development, Ltd., is completing the SRN-2, a 27-ton craft, at Cowes, in the Isle of Wight, and will start test runs early next year. This version will carry 66 passengers and will be powered by four Blackburn A-129 free turbines, pushing it to 70 kt.-plus speeds. A 100-ton version also is projected.

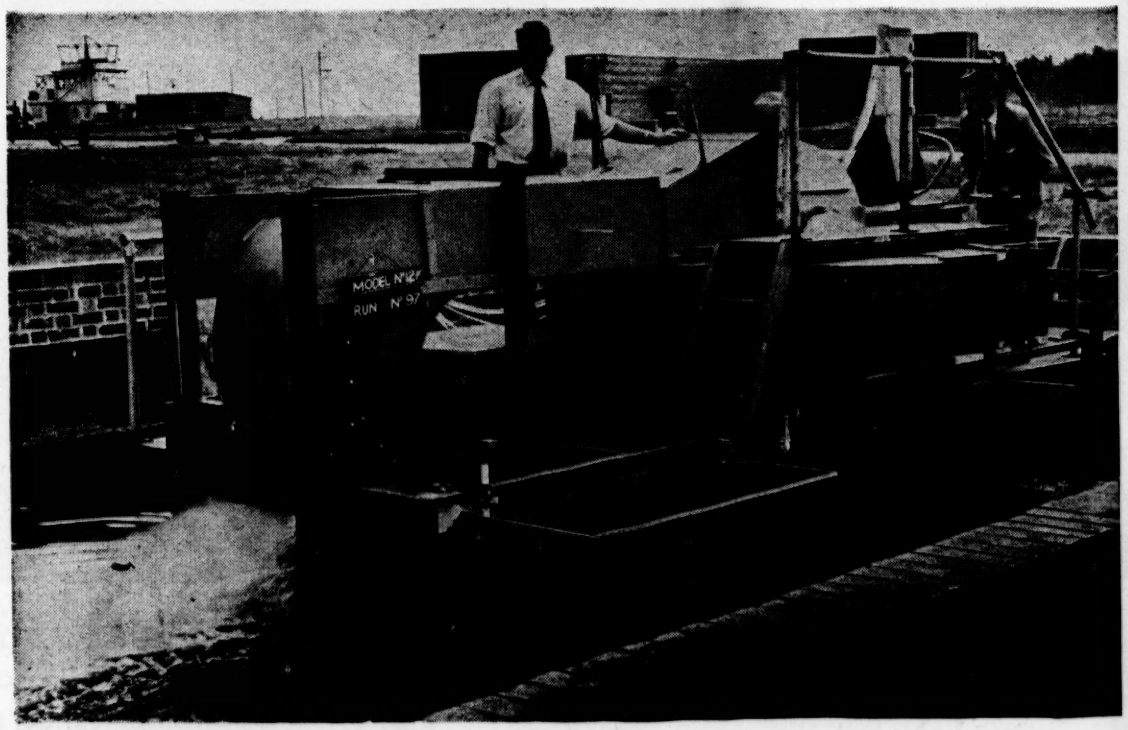
• **William Denny & Bros.,** Dumbarton shipbuilding firm, has built a 4.5-ton vehicle, employing sidewalls which remain in the water, and is working on a larger version which will come out next year.

• **Britten-Norman** has its Cushioncraft on trial runs, powered by a Rolls-Royce V-8 conventional engine and carrying 10 persons. This is a company-financed project independent of collaboration with Hovercraft Development.

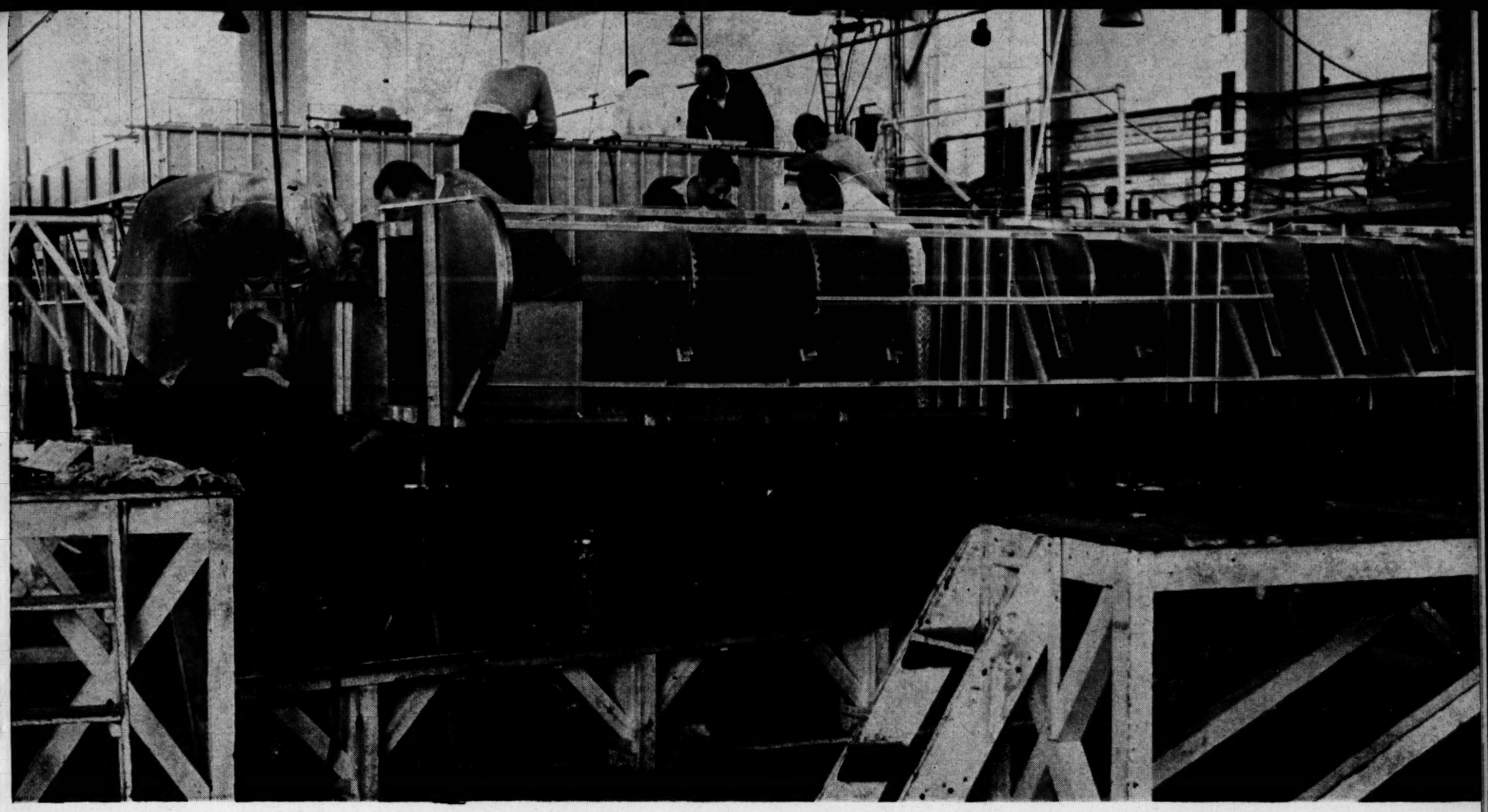
• **Folland Aircraft** has built a ground effect research machine (GERM) for study of a range of what it calls "hovertrucks," primarily cargo carriers with speeds up to about 30 mph. and designed for rough terrain.

Entire field has been given stimulus by British commercial interest in a potential Channel-crossing vehicle, and the government is participating through its National Research Development Corp., of which Hovercraft Development is a subsidiary. Starways, an independent airline, already has requested hovercraft routes in the eastern U. K.

A prime mover in this area is Hovercraft Development's C. S. Cockerell, inventor of the hovercraft principle, and who feels the program is getting



VARIOUS DUCT and skirt shapes to contain water spray are tested on this vehicle.



FIRST VA-3 CRAFT, which will carry 24 passengers, is under construction at South Marston. Photo shows forward end.

Development

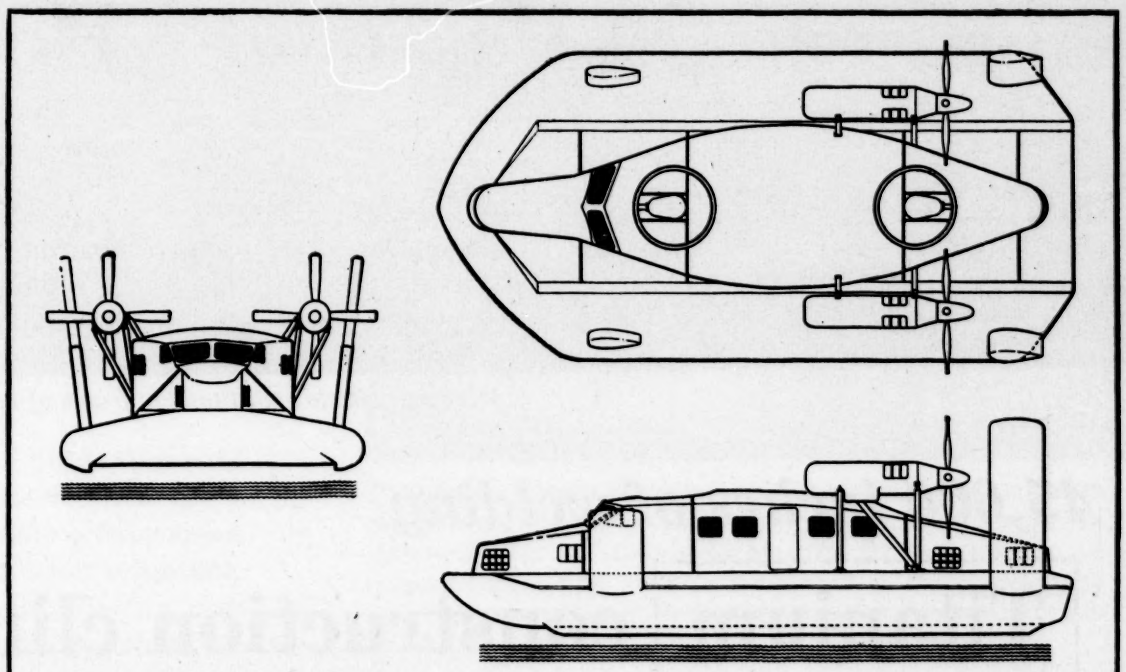
far too little emphasis (AW Aug. 28, p. 57).

At Vickers-Armstrongs, the director and general manager, S. P. Woodley, is quick to point out that the VA-1 has no commercial application and is purely a research vehicle. Currently, tests are centering on control problems at speeds of about 30 kt. and control of spray through a varied range of ducts and vents.

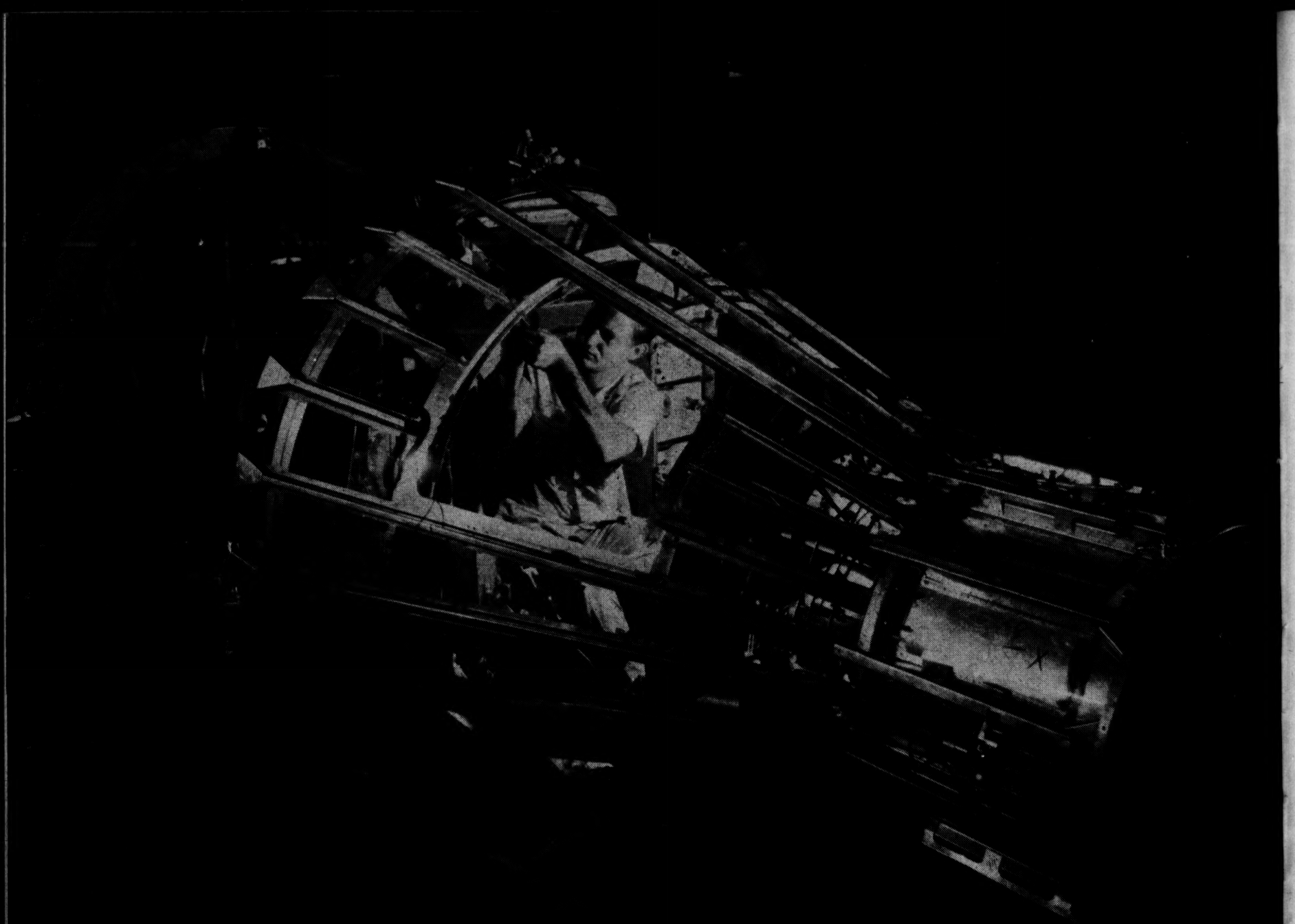
Powerplant is a Continental engine but hardware has been kept sufficiently uncomplicated to allow the company to use a variety of engines. The VA-1 now rides on an air cushion of about 5 in., contained in a large overhang. The fore and aft ducts contain spoilers to alter pitch, and side spoilers are installed for lateral controllability. Two large fins behind the externally mounted propeller and engine provide directional control.

The craft, officials said, is relatively uncomplicated and checkout of an untrained person would take about two days. No one has yet come up with a name for this "person"; Vickers has tried driver, pilot and captain to little avail.

In this realm, licensing is a problem as yet unsolved. Vickers-Armstrongs' research vehicle has an Air Registration Board number classifying it as experimental aircraft, but officials at South Marston are convinced that a new set of rules must be written when the concept has reached commercial maturity. Starways made its application to the Air Transport Licensing Board, which has



VICKERS-ARMSTRONGS VA-3 three-view is above; wind tunnel model of VA-2 is below.



Mercury capsule's all-titanium frame of hat-section stringers and machined rings.

45,000 inches of welding

Titanium construction clinches record of reliability with Mercury capsule!

Mercury's astronaut, and all that was at stake with him, rode out the big shot safely in a titanium structure. Chosen for its light weight, its strength and rigidity at high temperatures, its ease of fabrication, titanium has passed another milestone in its growing history of reliability.

Project Mercury's pressurized capsule, its antenna and parachute housings and the adapter section mating it to the booster are basically titanium structures. They consist of a titanium inner skin attached to a framework of titanium stringers and rings. Beryllium and Rene 41 heat shielding "shingles" are fastened to the outside of the capsule.

The use of titanium has saved "considerable" weight over other metals of similar strength and endurance in the all-critical weight battle in the Mercury capsule and adapter section where ounces were fought for.

This report has been prepared by Titanium Metals Corporation of America in the belief that performance of titanium in the space capsule may provide information of use to you in design and construction of weight-critical airframe structures, whether they be in VTOL or STOL aircraft, or vehicles to operate in space.

Rigidity and strength at high temperatures . . . and 20 G's! Shaving off pounds was not enough for Mercury's designers. One of the big factors in the selection of titanium, which is as strong as most steels, yet weighs 44% less, is its ability to retain its strength and rigidity at high temperatures.

During the launch phase, the all-titanium adapter section reaches 600F. The titanium stringers in the capsule reach 600F during re-entry; the inner skin reaches 200F. Here titanium construction proves its high performance and reliability. Mercury capsule is designed to withstand 20 G's.

Titanium construction inherently rigid. Titanium lends itself to an actually stiffer construction even though its modulus is somewhat lower than steel's. The answer is a greater cross-section made possible by the less dense titanium. Moreover the metal will retain its stiffness over a wide range of temperatures.

Added stiffness and efficiency can be gained by "rigidizing" or beading. Mercury inner skin, which is also the cabin inner wall, consists of two layers of 0.010" commercially pure titanium, welded together to form a single "sandwich" structure. The inner layer is flat-rolled. The outer layer has been stiffened with corrugations approximately 3 inches in length and ½-inch wide. The result is a 0.020" titanium section that is equal in rigidity to an 0.050" section . . . 150% increase in efficiency.

45,000 inches of reliable welds per capsule. Project Mercury capsule, in addition to its high G loadings and temperature requirements, is pressurized to maintain its cargo of human life. Welds *must* be reliable.

According to McDonnell Aircraft, St. Louis, Mo., developers and manufacturers of the capsule, there are 24,500 inches of seam and butt weld and 20,500 inches of spot weld in each capsule . . . 45,000 inches of welding. The performance has been repeated in 20 production capsules.

Here indeed is a better focus on the reality of titanium welding!

All fusion and seam and spot welding was done "open air." Fusion welds were inert-gas shielded, tungsten-arc, using trailing and backup shields. Welds are as strong or stronger than parent metal, McDonnell reports.

Spot and seam welding was accomplished on standard production equipment, with techniques similar to those used on the stainless steels.

TMCA: your information source. If your missile or aircraft problems revolve around requirements for a rigid, high strength structure at temperatures from *minus* 433 to plus 1000F . . . with high corrosion resistance, including immunity to atmospheric attack, titanium may easily be your best answer. The reliability on which the makers of the Mercury capsule placed their faith can work for you.

We suggest you get in touch with the nearest Titanium Metals Corporation of America sales office or write directly to our Technical Service Department for information on titanium application . . . fabrication . . . competent fabricators. Why not write today . . .

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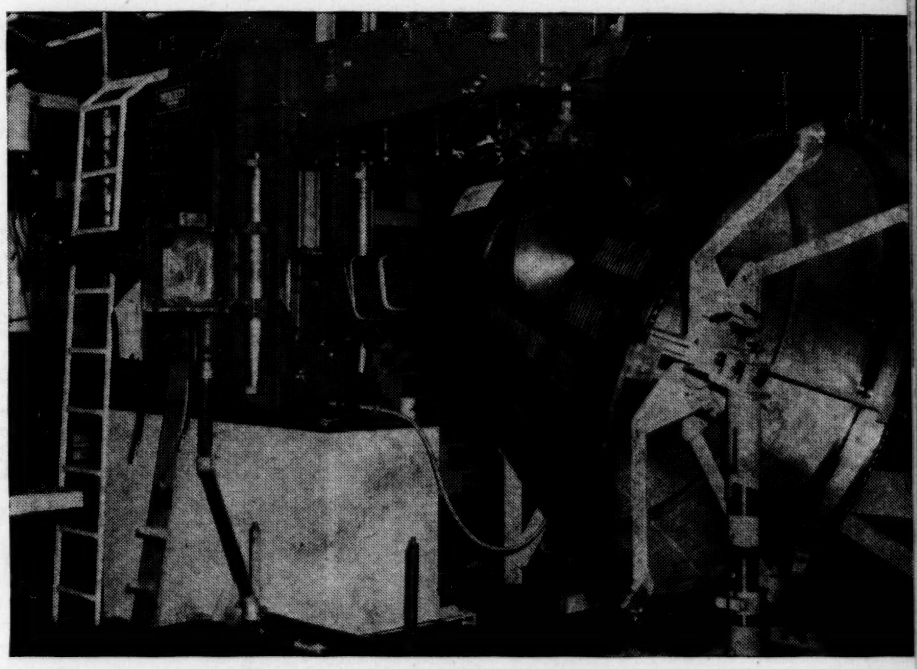
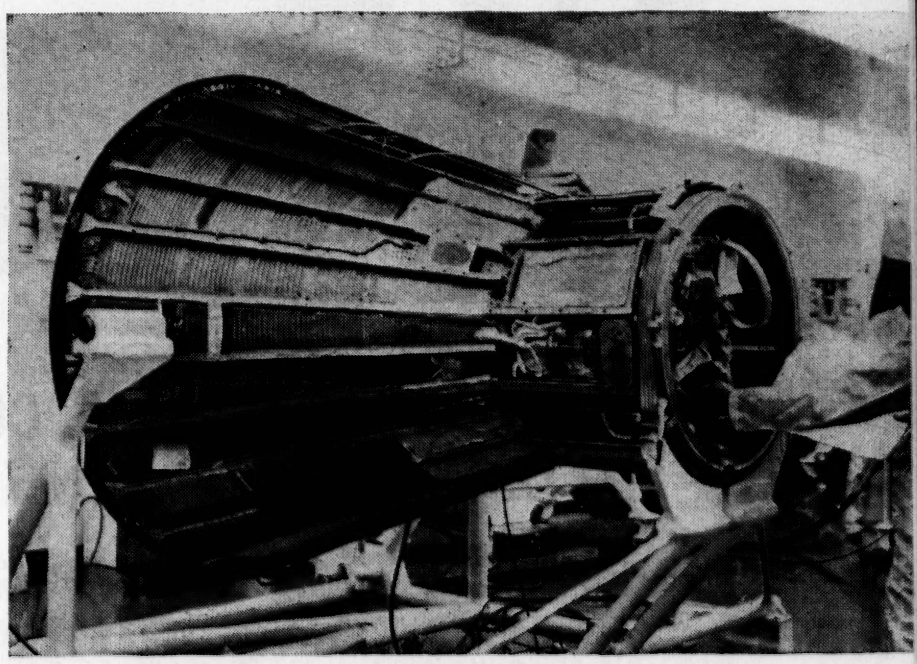
Titanium inner skin consists of two truncated cones 6½' high by 6½' at base, welded together. Cones are formed from trapezoidal sections, butt-welded together. One cone consists of 0.010" beaded titanium, for added stiffness; the other cone of flat-rolled 0.010" titanium. After butt-welding, each cone is individually pressure tested.



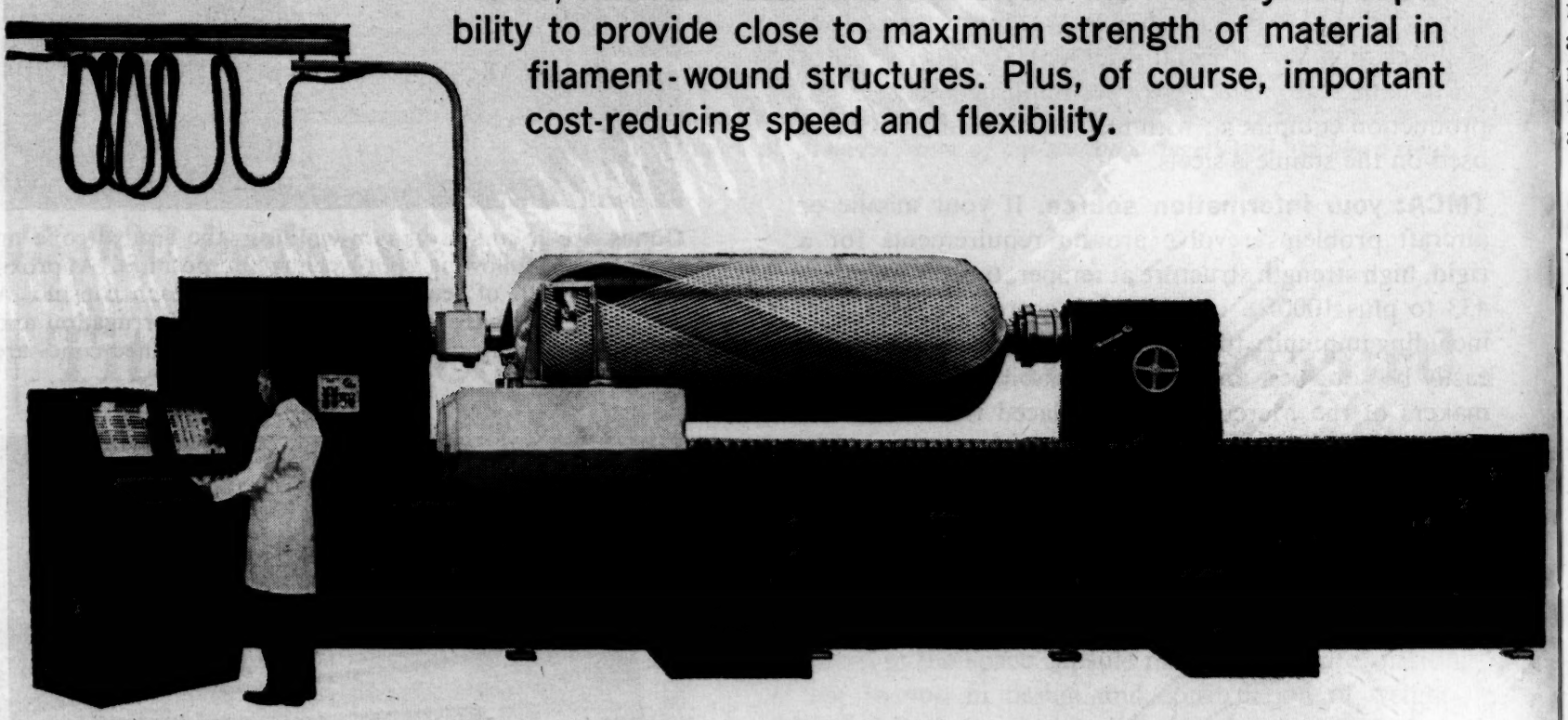
Cones are joined by seam-welding, the beaded cone on the outside, following spot-welding for position. Approximately 24,500" of seam weld are used in each capsule. A circumferential pass is made between each corrugation and a vertical pass adjacent to the corrugations. Joined cones are also proof-tested.



Basic titanium capsule structure consists of welded, two-layered cones which are spot welded to the titanium frame. The housing and adapter sections are not pressurized and consequently the skins are riveted to the frame in these areas.

ROHR WINDS UP LEADING THE FIELD

The industry's first tape-controlled, continuous-path filament winding machine is in full production now. Designed and built by Rohr, it wraps glass fibre filaments with amazing precision to form lightweight structures of great strength, such as the rocket motor case shown below. It is capable of winding parts up to 25 feet in length and 8 feet in diameter—and has the ability to wind an infinite variety of patterns, including a continuous filament pattern for multiple-nozzle motor cases. Actually, the wrapping of different pressure vessels is as simple as changing the tape. This advanced machine demonstrates Rohr's unique skill in designing and building highly specialized manufacturing equipment...plus knowledge gained from years of programming and production of three-dimensional parts by numerical control. The ability to produce precision-wound products on this new filament winding machine demonstrates the breadth of our research into plastics and adhesives and the depth of our experience in collapsible mandrel manufacture. Because it achieves such precise and uniform positioning of filaments, this Rohr machine now offers the industry the capability to provide close to maximum strength of material in filament-wound structures. Plus, of course, important cost-reducing speed and flexibility.



ROHR NUMERICALLY CONTROLLED FILAMENT WINDING MACHINE

For information on this and other Rohr production techniques please write Mr. A. R. Campbell, Sales Manager, Dept. 61, Rohr Aircraft Corp., Chula Vista, Calif.

Main Plant and Headquarters: Chula Vista, California / Plant: Riverside, California / Assembly Plants: Winder, Georgia; Auburn, Washington

ROHR
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taken no action yet, since, unofficially, board members are not sure hovercrafts are in their control.

In the meantime, work is being accelerated on the VA-2 and VA-3, with the VA-2 kept to a 28 ft. 4 in. length to facilitate airlifting to demonstration points. This vehicle will use three piston powerplants, one to provide a 8.5 in. lift cushion, and the others for propulsion.

The VA-3, Vickers-Armstrongs claims, will operate in river estuaries and similar terrain, with waves up to 2 ft.

Range will be about 80 naut. mi., carrying 24 passengers plus crew, or refitted to cargo configuration with a 4,000-lb. capacity.

Main Structure

Main structure, mostly of aluminum alloy, consists of a buoyancy tank and ducting system. Fuel tank is divided into two compartments, each with its own submerged fuel pump; compartments can be linked by a cross-feed.

Cockpit is a forward cab, with controls and equipment for a single operator. Room is available for another crew member.

Future research is concentrated on development of flexible structures to take impact and abrasions, and has already been tried with rubber skirtings and vents in the SRN-1. Main problem is material life and the company says it may take up to 10 years to develop a servo-actuated mechanical device.

Skid Computer Device Derived From B-70

Los Angeles—Computer-based anti-skid device for high performance aircraft has been developed to compare the speed of rotation of the main landing gear wheels with that of a small unbraked extra wheel, thereby extrapolating a measure of main wheel slippage.

The idea emerged from the North American B-70 supersonic bomber program. The anti-skid computer would use information on slippage, wheel load, brake torque and speed to calculate when a skid is about to begin. The system would then modify brake pressure to prevent the skid. The extra wheel of the system also provides a better indication of ground speed than earlier aircraft have had. North American claims that the fifth wheel anti-skid device would enable the 2,000-mph. B-70 to land on any runway capable of handling the Boeing B-52.

The landing gear subsystem and the brake control system for the B-70 were developed by Cleveland Pneumatic Industries and the wheels, brakes and tires were designed by the B. F. Goodrich Co.

The Lincoln Laboratory program for ballistic missile range measurements and penetration research includes:

EXPERIMENTAL RESEARCH

Measurements and analysis of ICBM flight phenomena for discrimination and for decoy design purposes, including optical, aerodynamic and RF effects.

SYSTEM ANALYSIS

Studies to apply research findings to advance the technology of ICBM and AICBM systems.

INSTRUMENTATION ENGINEERING

Designing radar, optical and telemetry equipment with which to measure ICBM flight effects under actual range conditions.

RADAR SYSTEMS RESEARCH

Extending the theory and application of radar techniques to problems of discrimination, countermeasures and performance in a dense-target environment.

HYPERSONIC AERODYNAMICS

Study of the flow-fields around re-entering bodies for various body designs and flight conditions. Excellent computer facilities available.

RADAR PHYSICS

Theoretical and experimental studies in radar back-scattering. Interaction of RF radiation with plasmas.

• *A more complete description of the Laboratory's work will be sent to you upon request.*

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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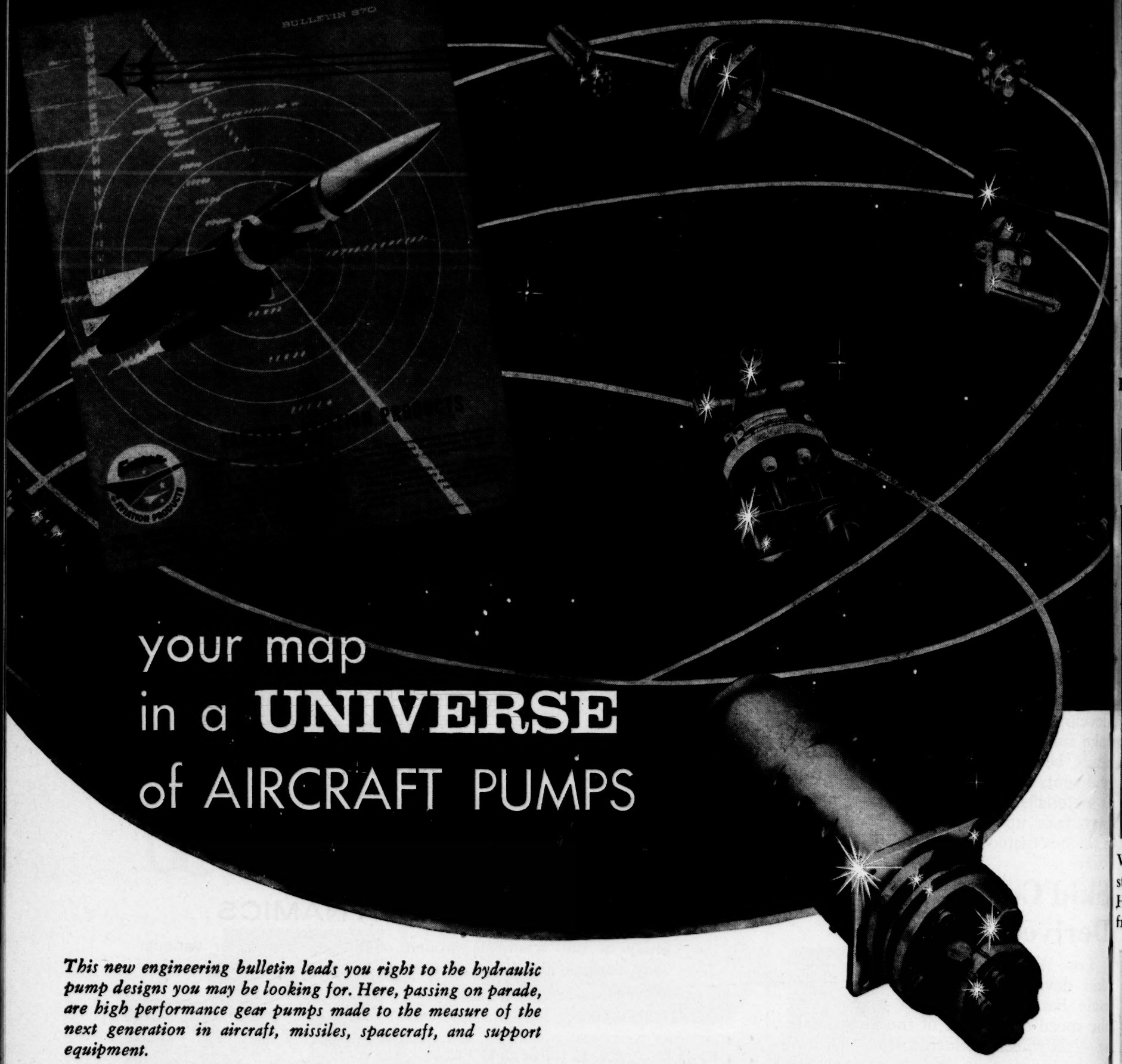

This new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, passing on parade, are high performance gear pumps made to the measure of the next generation in aircraft, missiles, spacecraft, and support equipment.

Many of these units are the product of ready-made, mass-produced components that can be teamed into the precise configuration you need. Custom-designed pumps are also available.

All have in common these classic Eastern hydraulic pump characteristics:

SMALL SIZE: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" x 1⅞" x 2¾", weighs 9 oz.

WIDE PERFORMANCE RANGE: pumps available have theoretical displacement from .0016 to 1.30 cu. in. per revolution — flow from .025 to 9.6 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

UNAFFECTED BY EXTREME ENVIRONMENTS: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

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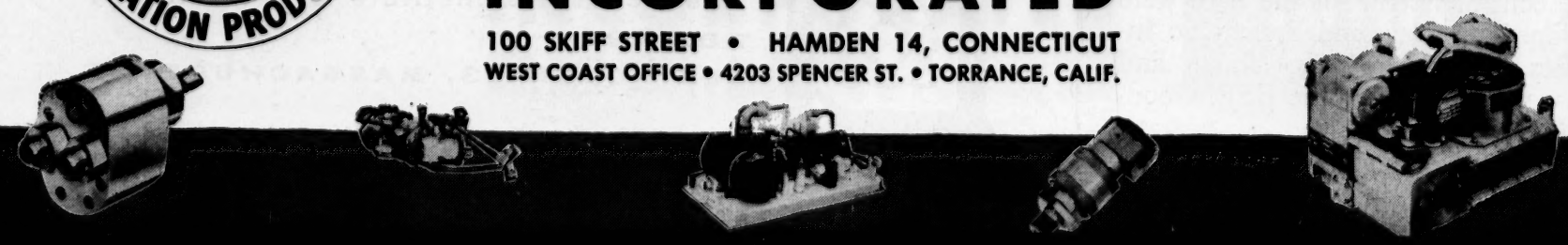
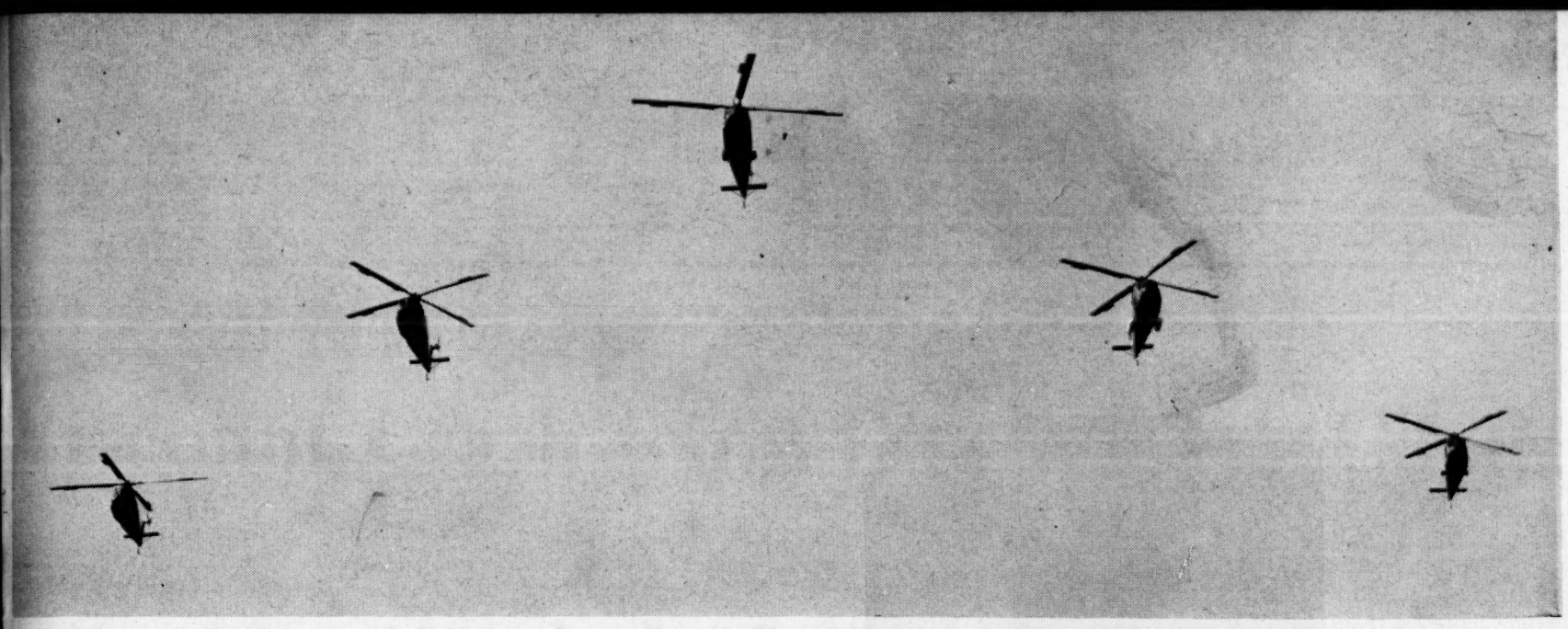
Other Eastern products:
- hydraulic motors
- servovalves, amplifiers, actuators and systems
- pressurization/dehydration packs
- quick-disconnect couplings
- electronic tube cooling units





Five of first nine HU2K-1s to reach flight status fly over Kaman's Bloomfield, Conn., facility. Note servo flaps on rotor blades.

Five of Nine HU2K-1s in Flight Status Fly Formation

White tank on fourth Navy Seasprite from right, above, is an auxiliary fuel tank. Kaman has produced 28 of the helicopters to date. Next steps in the HU2K program are structural demonstrations and Board of Inspection survey at NAS Patuxent River, Md. Although the HU2K-1 was designed as a utility-rescue aircraft, it is being adapted for anti-submarine warfare tests. Kaman recently received a contract from the Navy to install ASW gear in the helicopter. Rotor system consists of four-blade main rotor and three-blade anti-torque rotor.

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THE BENDIX G-15 COMPUTER...is daily demonstrating its ability to save time and money at hundreds of installations in industry after industry...has established an overall reliability record of 97.4%. Other reasons behind continuing G-15 leadership: ease of use...over 1000 programs immediately available at no charge...versatility and expandability resulting from the widest selection of input-output accessory units. Continuing systems support in depth and a vigorous users EXCHANGE organization combine to broaden application usefulness...assure maximum system effectiveness at minimum cost. Speaking of cost, G-15 proven performance is yours for as little as $1,485 a month. Investigate the Bendix G-15...prove to your own satisfaction how its demonstrated superiority can bring important time and dollar savings to your organization.

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THE Bendix CORPORATION

CAB Accident Investigation Report—Part II:

Viscount Crash Icing Discrepancy Cited

(This is the conclusion of a Civil Aeronautics Board accident investigation report on the crash and burning of a Capital Airlines' Viscount near Charles City, Va., Jan. 18, 1960. The first part of the report which appeared in AVIATION WEEK, *Oct. 9, p. 99, described how the flight, which originated in Chicago's Midway Airport and was to terminate at Norfolk, Va., with a stop at Washington D. C., crashed into a wooded area near Charles City killing all 46 passengers and four crew members. The Board reports that the accident was caused by delayed arming of the engine ice protecting system while flying through icing conditions, causing eventual flameout of the four engines.—Ed.)*

An analysis of the weather indicates the temperature and moisture content of the air at 8,000 feet, Flight 20's assigned altitude, were conducive to icing to the extent that ¼ to ½ inch of airframe ice accumulation could have built up on the portions of the airframe of N 7462 while en route to the accident site.

In the investigation of this accident, the Board undertook to determine the number and reasons for the known instances in which Rolls-Royce Dart engines inadvertently shut down in flight. The review shows that the reasons for engines losing power simultaneously have been generally due to either late selection of the anti-icing equipment, or to fuel starvation caused by ice formation in the fuel lines, and/or the presence of a large amount of water in the fuel. There have been a total of 18 reported cases involving 18 airplanes in which multiple engine loss of power has occurred. However, in all of the instances which deal with late selection of the anti-icing equipment, the engines either recovered normally or were successfully relit. It was only in the cases—eight in number—which were concerned with ice in the fuel line or excessive water in the fuel that difficulty with relighting occurred. This information is based on reports received by Rolls-Royce from airlines on a world-wide basis and covering about 11 million engine flying hours.

Refueling Activities

All refueling activities of Flight 20 were investigated and found to be negative as far as contamination of fuel was concerned. The investigation also revealed that the hot-air gate valves of the four engines were in the closed position at the time of impact. Had a blockage in the fuel lines existed due to ice, the hot-air gate valves would have automatically opened to permit the hot air to pass to a heater in the fuel supply line.

Since there appears to be no evidence of fuel starvation or fuel contamination, the Board's investigation directed careful scrutiny to the possibility that Flight 20 experienced flameout of a sufficient number of its engines to preclude flight.

The principle of the anti-icing equipment aboard Flight 20 is to permit a small buildup of ice on the engine cowls of each engine and then to turn on the electrical current to actuate the engine cowl anti-icers so that the ice breaks off and goes into the engine. Early testing of the cowl anti-icing system was directed towards determining the correct length of time which the anti-icing equipment should be "ON" and the length of time which the heat to the cycle-heated pads of the engine cowl should be "OFF". As a result of this testing, a cycling time was selected and incorporated in the present Viscount cowl anti-icing system.

This system, when armed, would be able to combat the worst icing conditions. The anti-icing installation aboard Flight 20 was approved by both the British Air Registration Board, and the American Civil Aeronautics Administration (FAA) as fulfilling the necessary requirements for such a system.

To avoid excessive accumulation of ice on the power units of the Viscount, the power unit ice-protection system should be switched "ON" during every flight at all times when the indicated outside air temperature is below plus 10°C, except when it is certain that icing conditions will not be encountered. One of the first visual indications of ice is its formation on the windshield wipers.

By the time this is apparent, a fair amount of ice could have accumulated on the engine cowls. The anti-icing system should be turned on well in advance of anticipated icing conditions in order to allow the inlet duct to warm up enough to prevent excessive ice from forming. If ice has been allowed to accumulate and the system is armed late, heating underneath the ice formation is quite rapid since the ice acts as an insulator. If ice has formed and the ice-protection system is turned on, sufficient heating occurs in approximately 30 seconds and de-icing will result. Under these circumstances, there is a good possibility that the entire ice accumulation around the inlet duct circumference will slip off and go through the engine en mass. The release of a large amount of ice from the inside part of the nose cowling, due to the late arming of the engine ice-protection system, would have been sufficient to flameout any of the engines.

The Board is aware that it has no factual information as to the precise sequence of events which occurred at 8,000 feet when Flight 20 began to sustain difficulty. However, the facts the Board does have support a probable sequence of events.

Capital Flight 20 reported over Tappahannock low-frequency range at 2201, at 8,000 feet, and estimated Hopewell VOR at 2212. At this time the Norfolk ARTC Center transmitted a clearance to Flight 20, clearing it to the Norfolk ILS Outer Marker from over Tappahannock. This transmission was completed at approximately 2205, at which time nothing of an unusual nature was reported aboard the aircraft. The accident site is approximately 40 nautical miles south of Tappahannock, and approximately 14 minutes elapsed between the completion of the transmission and impact, which occurred at approximately 2219.

During this period of night flight, the crew of Flight 20 was confronted with a sudden emergency which required their complete attention, to the extent that no attempt was made to contact anyone by radio for the purpose of either declaring an emergency or requesting descent to a lower altitude.

Ice-Protection System

The Board believes that at some period of time between 2205 and 2219, all four engines of the aircraft ceased to deliver power and their propellers feathered. The Board believes that this was due to the late arming of the ice-protection system. The first flameout could have been followed immediately by other flameouts or there could have been an undetermined period of time between the flameouts. The delay in arming the ice-protection system was probably due to one or more of the following factors: (1) Captain Fornasero was apparently not aware of Change 15 of the ARB Manual, stipulating that "the ice-protection systems for all four engines must be switched 'ON' during every flight at all times when the indicated outside air temperature is below plus 10°C, except when it is certain that no icing will be encountered"; (2) late anticipation, i.e., Captain Fornasero may not have taken action to arm the system until he observed visible indications of ice accretion; (3) variations in the outside air temperature gauge and the anti-icing thermostatic probe indications due to variations in compressibility, e.g., with indications of plus 5°C, the actual temperatures could have been as low as plus 2°C.

When the flameout occurred, the crew would presumably have followed their current Viscount emergency checklist which called for an immedate relight or a descent to below the freezing level to allow the engine to de-ice naturally. During this time, attempts might have been made to start the flamed out engine or engines. The Board believes that more than one engine must have flamed out before the descent was begun. Had only one engine flamed out, the crew would most likely have continued their flight at the assigned altitude.

Prior to beginning the descent, the air-

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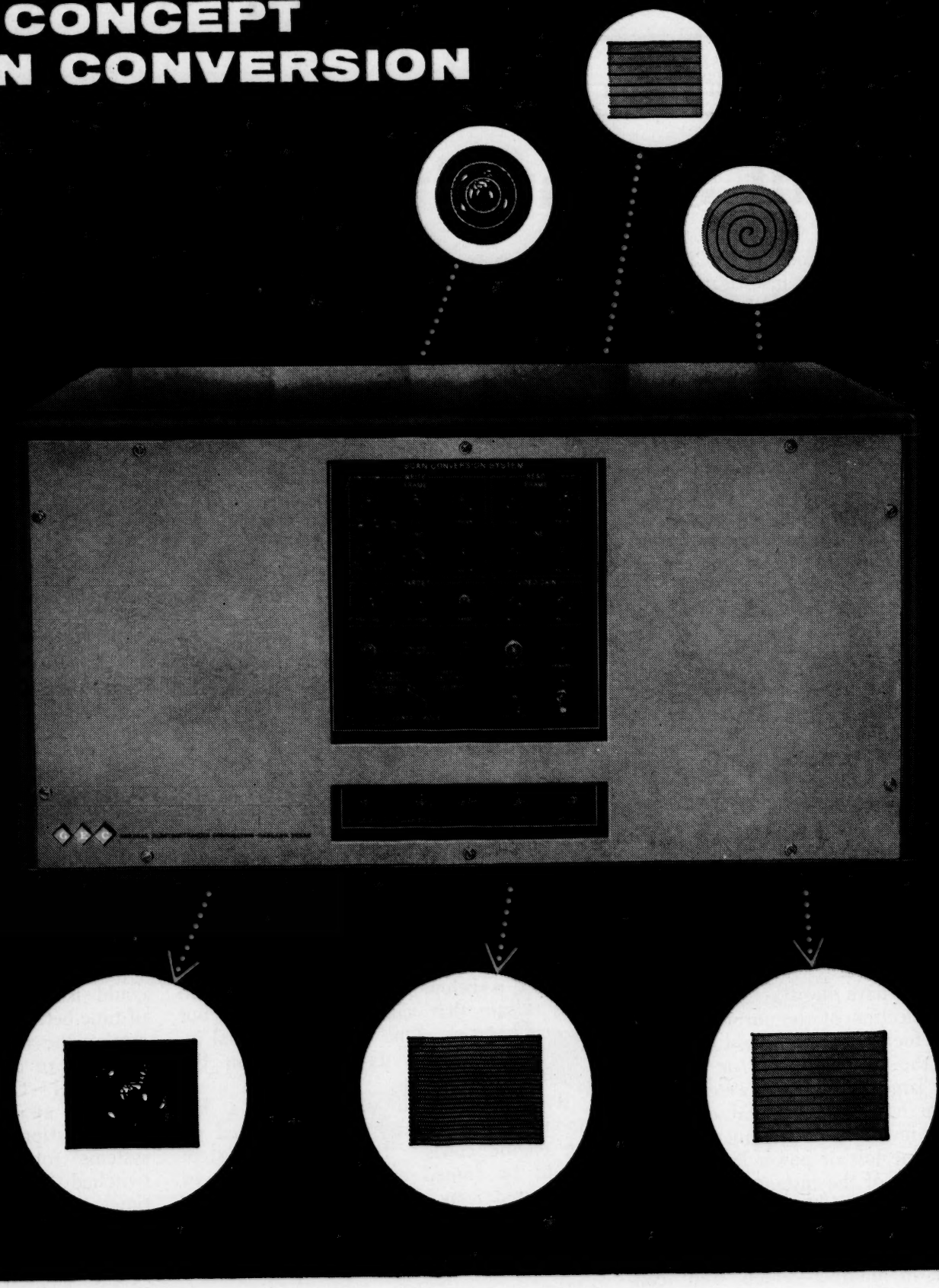

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craft would have been operating near V_{no}—the normal operating limit speed of 237 knots. During the descent, the throttles of any remaining engines could have been moved toward the closed position and to below the auto-feather arming position. This throttle reduction might also have been required if the aircraft had penetrated an area of light to moderate turbulence en route.

During the descent, the aircraft would be entering progressively warmer air. Any remaining engines would have been operating at a low r.p.m., JPT, and thrust setting, and could have flamed out either because of ice ingestion brought about by the warmer air, or because the anti-icing system was left "ON" during descent to warmer air. Additional drag would have been experienced by the windmilling of the remaining propellers since they would not auto-feather until the throttles were advanced to above 13,400 r.p.m.—the auto-feather range.

Having followed the then-used checklist by descending to a lower altitude, the crew would level off after reaching an altitude where the outside air temperature was above freezing and go through the standard drill for relighting without further loss of altitude. As the throttles of the engines that had been operating at the beginning of the descent were advanced, the propellers would auto-feather if they had flamed out due to ice-ingestion during the descent. By this time, the complexity of the situation would have magnified itself to extreme proportions. The airspeed would drop off rapidly, and the aircraft would continue to lose altitude.

Restart Try

The crew would then try jointly to restart any of the engines and to keep control of the aircraft, sacrificing speed for altitude. It is estimated that considerable altitude would have been lost and that three or more minutes would have elapsed since the emergency occurred. During this time numerous efforts would have been made to restart the engines. However, battery energy would have fallen below the required voltage necessary to successfully unfeather a propeller and relight an engine.

A study of numerous Capital Airlines Viscount flights operating at night disclosed that the electrical load being used aboard N 7462 at the time of the emergency was from 500 to 600 amps. If the electrical system were not switched over to the emergency bus system during an emergency in which several engines cease to operate and their propellers automatically feather, all the electrical units in use would continue to draw their energy from the battery.

The flight test demonstrated that under similar flight conditions using approximately the same electrical load, the battery energy would fall within 1½ to 2 minutes to below the required voltage necessary to successfully unfeather a propeller and relight its engine. One or more engines running with generator "ON" would supply sufficient electrical energy to feather or relight any of the Viscount engines. A fast windmilling propeller would also furnish enough rotational motion and, in turn, sufficient electrical energy to accomplish propeller unfeathering or engine relight.

If the engines could not be started, efforts could be made to drive the propellers out of feather by windmilling. The aircraft would have to be dived to approximately 150 knots to drive the outboard engines, Nos. 1 and 4, out of feather. Approximately 180 knots of airspeed would have to be attained to drive the inboard engines, Nos. 2 and 3, out of feather.

The fact that Nos. 3 and 4 engines were found to be developing power at impact indicates that these engines were successfully started at some time before impact. If two of the engines were operating continuously, it is doubtful that the aircraft would have lost altitude since it is certificated to maintain altitude at maximum gross weight with two engines inoperative. Since the investigation revealed power was available on Nos. 3 and 4 engines at impact, and something adverse occurred between 8,000 feet and impact, it is logical to assume if the crew had available to them energy to relight, then relight would have been experienced and sufficient altitude would have been maintained.

No. 4 engine was successfully driven out of feather position and relit. During this time, relighting attempts caused an accumulation of fuel to be deposited in the burners, so that explosive relights occurred, bringing about the noises of engine surging and backfiring heard by the witnesses.

The crew now used full power on the No. 4 engine to assist in checking the severe settling of the aircraft, causing the aircraft to turn to the left. During the last circuit, and as No. 3 engine started, the aircraft was probably operated with full cross controls and was settling rapidly. In order to stop the unwanted turn, it is probable that the crew reduced power on No. 4 engine, with the thought of advancing power on Nos. 3 and 4 engines together after the turn was stopped. Such a reduction of power at a time when full opposite control was being used would arrest the turn but cause greater settling of the aircraft. An application of power was made at or about the time of tree contact. However, it was too late to develop power on No. 3 engine or to supply sufficient power for a climbout. It is possible the crew observed the ground just before impact and applied back elevator pressure on the control column, causing the aircraft to whip-stall. The aircraft then struck the ground before it whipped into the steep nose-down attitude characteristic of the whip-stall.

Inoperative Engines

Flight tests disclosed that with three engines inoperative and full power on No. 4 engine, full left rudder and full right aileron, much difficulty was experienced in the attempt to maintain directional control and the result was a slow turn to the left. When power was removed from No. 4 engine, the aircraft would enter a high rate of descent.

Numerous earwitnesses reported hearing "popping noises" or "cutting in and out" of an engine or engines as the aircraft made several circuits to the left just prior to impact. In evaluating the auto-feathering and relighting procedures, the Board believes a logical explanation for these reported sounds can be given. The auto-feather feature is armed and capable of operation throughout the range of throttle positions

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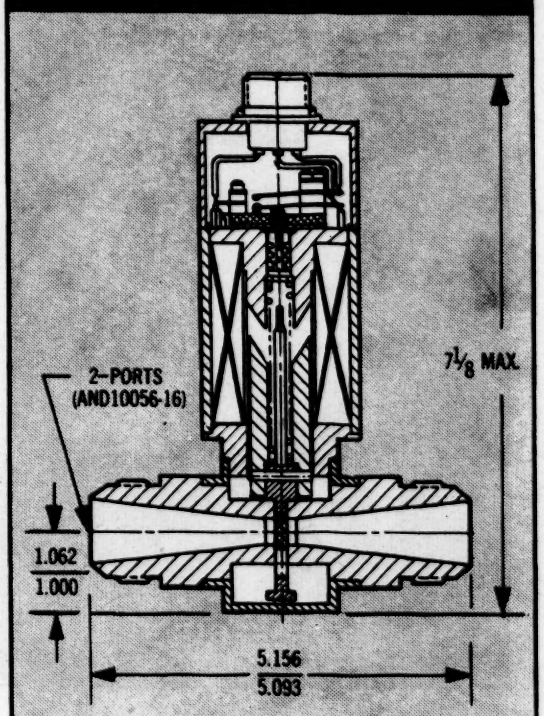

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from cruise to takeoff—that is, from 13,400 to 14,500 r.p.m.

Below cruise throttle position the throttle switches are open, and the auto-feather feature is ineffective. During rapid acceleration the throttles may reach the position at which these switches are set before the torque pressure has had time to rise above 50 p.s.i. However, in the event the relight is not completed the propeller will go toward the feather position. This process is of very short duration and does, in fact, assist the acceleration.

If partial relight should occur, the throttle may be closed and opened rapidly to about 12,000 r.p.m., to effect a complete relight. In the event this action does not achieve a complete relight, it is then necessary to refeather and wait two minutes for fuel drainage before repeating the unfeather procedure. However, in an emergency, successive attempts to relight may be made.

High Pressure Cock

In the event the high pressure cock is not placed in the feather position subsequent to the propeller auto-feathering, fuel could collect in some parts of the combustion chamber. In addition, if the throttle were partially open and the unfeathering switch operated to obtain unfeathering oil pressures and ignition, there could be an explosive relight. This action could be repeated a few times within the 30 seconds relight-time-switch cycle, thus giving rise to a "popping noise."

As stated earlier, the Board believes Nos. 1 and 2 propellers were auto-feathered—a condition which is substantiated by the fuel found in the snout area of the No. 3 combustion chambers of these engines. Furthermore, fuel in this location supports the assumption that the high pressure cock was in the open position.

The Board believes that the most likely sequence of events, based on the reported engine sounds and the known procedures for accomplishing a relight of Dart engines, consisted of an attempt to drive the propellers out of feather by windmilling, followed by multiple attempts to relight one or more engines. Successive relights were interrupted by auto-feather action initiated by premature advancing of the throttle prior to complete lightup.

During the investigation, No. 3 engine igniter points were found considerably eroded. This raised some speculation as to whether such a condition could be a factor in delaying relight of No. 3 engine until just prior to impact. The igniter boxes of all four engines were bench-checked and found to be capable of operation. Investigation revealed that the erosion noted on these igniter points was the result of time in service since overhaul and not a contributing factor in this accident.

Change Disseminated

During the investigation of this accident, the Board discovered that the Change No. 15 to the ARB Flight Manual had been disseminated to all Viscount operators for a period of 19 months prior to the accident and included in the manuals carried in the Capital Airlines' Viscounts, but the material had not been incorporated into the Capital Airlines Flight Training Manual furnished to all the Capital Viscount pilots and utilized in the ground school instruction for Viscount aircraft. Nor was this material incorporated in the pilot emergency and routine checklists.

The Board's investigation of this accident revealed further that at the time of and subsequent to the accident, many Viscount pilots of Capital Airlines were not aware of the change to arm the power unit ice-prevention system at plus 10°C instead of at plus 5°C, despite the fact that this change became effective July 1958.

Conclusions

After an evaluation of all evidence, the Board concludes that Capital Airlines Flight 20 of January 18, 1960, entered an area of weather en route to Hopewell VOR which was conducive to icing; that because of certain discrepancies in the anti-icing instructions, several engines flamed out due to delayed arming of the Viscount engine ice-protection system; that in efforts to relight the several engines which had flamed out, the remaining engines flamed out because of intake icing and actuation of auto-feathering. Several moments passed during which all four engines' propellers feathered, airspeed decreased, and considerable altitude was lost. Engine rotation ceased for a sufficient time to cause a drop in battery electrical energy to below the required voltage necessary to successfully unfeather a propeller and relight its engine. Additional altitude was lost when the aircraft was dived in efforts to drive the propellers out of feather by windmilling. The crew was eventually successful in its attempts to drive No. 4 propeller out of feather and relight the engine.

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PROBLEMATICAL RECREATIONS 88

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n attempt to check the severe settling of he aircraft. With this asymmetrical power onfiguration, it is believed that direcional control was not maintained with the se of full opposite controls. As a result, nd, since the aircraft was apparently being lown near V_{mca} speed[2], several circuits to he left were made in the impact area. An pplication of power was made at or about he time of tree contact. The aircraft truck the ground with no forward velocity.

The weather at the time of departure rom Washington National Airport was suitble for the dispatching of the flight. There as no evidence of mechanical hindrance f failure in the engines, propellers, or accessories, and no indication of mechanical indrance in the relighting of the engines. There were no structural or control system problems.

The aircraft was adequately equipped to ope with both airframe and induction ice ccumulations.

Subsequent to this accident, the Board ade several operational studies of inflight rocedures practiced by Capital Airlines iscount pilots in connection with the use f the engine ice-protection system. As a esult of these studies, the Board, in a letter lated July 14, 1960, disclosed to the Fedral Aviation Agency that Capital Airlines iscount pilots were still not following roper procedures relating to the use of the ce-protection system.

As a result of this accident, Capital Airines dropped the phrase "descend to warmer limate for relight" from its emergency hecklist and instructed its Viscount pilots hat relight could be accomplished at any ltitude if the proper drill were followed. Capital Airlines also adopted a system of hecking pilots to ascertain that they had he benefit of the latest operating information.

Probable Cause

The Board determines the probable cause f this accident was the delayed arming of he engine ice-protection systems while flying n icy conditions, resulting in the loss of ngine power and attendant electrical energy equired to unfeather propellers and relight ufficient engines to maintain flight.

By the Civil Aeronautics Board:

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Chairman
ROBERT T. MURPHY
Vice Chairman
CHAN GURNEY
Member
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Member
WHITNEY GILLILLAND
Member

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified f this accident shortly after occurrence. An nvestigation was conducted immediately in ccordance with provisions of the Federal Aviation Act of 1958. A public hearing was eld at Richmond, Virginia, May 3 and 4, 1960.

At the time of this accident, Capital Airlines, Inc. was a Delaware Corporation and maintained its principal offices in Washington, D. C. The corporation held a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in the transportation of persons, property, and mail. It also possessed a valid air carrier operating certificate issued by the Federal Aviation Agency.

On June 1, 1961, Capital Airlines, Inc. was merged with United Air Lines, Inc.

Flight Personnel

Captain James B. Fornasero, age 50, was employed by Capital Airlines on April 1, 1941, and was promoted to captain February 14, 1946. He held a valid airman certificate with an airline transport pilot rating for airplane, multi-engine land, DC-3, DC-4, Lockheed Constellation, and Vickers Viscount aircraft type ratings. He had accumulated 20,850 flying hours, of which 3,560 were in the Viscount. His last first-class physical examination, taken on November 23, 1959, was satisfactory with no waivers. His last semi-annual proficiency check of July 19, 1959, and his last line check of January 12, 1960, were satisfactory.

Copilot Philip H. Cullom, Jr., age 36, was employed by Capital Airlines on July 14, 1953. He held a valid airman certificate with an airline transport pilot rating for airplane, multi-engine land, and aircraft type rating for the DC-3. He had accumulated a total of 5,215 flying hours, of which 2,952 were as copilot on the Viscount. His last first-class physical examination, taken on July 24, 1959, was satisfactory with no waivers. His last instrument and copilot check was satisfactorily passed on August 26, 1959.

Hostess Diane M. O'Donnell, age 26, was employed March 6, 1959. Hostess Brigitte F. H. Jordt, age 23, was employed March 25, 1959.

Vickers-Armstrongs Viscount, model 700D, N 7462, bore manufacturer's serial number 217. It was manufactured February 2, 1957, and purchased by Capital Airlines on March 2, 1957. Since new the aircraft had accumulated 9,247 hours. The aircraft was powered by Rolls-Royce Dart engines, model 510, which were equipped with Rotol propellers, model R 130/4-20-4/12E with RA 25842 blades.

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Western Air Lines is using a combination fixed air compressor and hydrant at Salt Lake City, Utah, for starting jet engines. The compressor unit, designated Air Partner, was designed by Greer Hydraulics, Inc., Los Angeles, and Atlas-Copco, Sweden, and consists of a rotary, twin-screw, positive-displacement compressor which is driven by a 250-hp. motor.

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[2] V_{mca}—minimum airborne control airspeed of approximately 108 knots for Flight 20's configuration and weight.

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AVIATION WEEK, OCTOBER 16, 1961

AEROSPACE CORPORATION 126
AMPEX INSTRUMENTATION PRODUCTS COMPANY 7
AMPHENOL-BORG ELECTRONICS CORPORATION, CONNECTOR DIVISION 68-69
ASTEK INSTRUMENT CORPORATION 123
AT ELECTRONICS, INC. 121
AVIATION WEEK & SPACE TECHNOLOGY 124-125
AVIEN, INC. 98

BARBER-COLMAN COMPANY, AIRCRAFT & MISSILE PRODUCTS DIVISION 88
BELL HELICOPTER CORPORATION DIVISION OF BELL AEROSPACE CORPORATION 67
BENDIX COMPUTER DIVISION, THE BENDIX CORPORATION 116
BENDIX PRODUCTS DIVISION, THE BENDIX CORPORATION 76
BRISTOL SIDDELEY ENGINES LIMITED 48-49

CHERRY RIVET DIVISION, TOWNSEND COMPANY 87
CINCINNATI MILLING MACHINES COMPANY, CIMTROL DIVISION 79

DOW CORNING CORPORATION 4

EASTERN INDUSTRIES, INC. 114
ELASTIC STOP NUT CORPORATION OF AMERICA ..... 4th Cover
ENDEVCO CORPORATION 58

J. W. FECKER DIVISION, AMERICAN OPTICAL COMPANY 92-93
FROST & SULLIVAN, INC. 5

GENERAL DYNAMICS/ASTRONAUTICS 71-72
GENERAL ELECTRIC COMPANY, METALLURGICAL PRODUCTS 90
GENERAL ELECTRIC COMPANY, SILICONE PRODUCTS DEPARTMENT 62
GENERAL ELECTRODYNAMICS CORPORATION 118
THE B. F. GOODRICH COMPANY, AEROSPACE & DEFENSE PRODUCTS DIVISION 20
GOODYEAR TIRE & RUBBER COMPANY, THE—AVIATION PRODUCTS 8-9

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION 15
HAYNES STELLITE COMPANY, DIVISION OF UNION CARBIDE CORPORATION 2
HEILAND DIVISION, MINNEAPOLIS-HONEYWELL REGULATOR COMPANY ..... 2nd Cover
HOFFMAN ELECTRONICS CORPORATION, MILITARY PRODUCTS DIVISION 89
HUMBLE OIL AND REFINING COMPANY 74
HYDRAULIC RESEARCH & MANUFACTURING COMPANY 94

INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION, INDUSTRIAL PRODUCTS DIVISION 63

JACK & HEINTZ DIVISION OF SIEGLER CORPORATION 77
JOHNS MANVILLE CORPORATION, INDUSTRIAL INSULATION DIVISION 78

KEARFOTT DIVISION, GENERAL PRECISION, INC. 80
KELSEY HAYES COMPANY 17
KIDDE AERO-SPACE DIVISION, WALTER KIDDE & COMPANY, INC. 6

LAVELLE AIRCRAFT CORPORATION 104
LINCOLN LABORATORY, M. I. T. 113
LIONEL CORPORATION, THE 11
LITTON SYSTEMS, INC., GUIDANCE AND CONTROL SYSTEMS DIVISION 121
LOCKHEED GEORGIA COMPANY DIVISION OF LOCKHEED AIRCRAFT CORPORATION 120

MB ELECTRONICS DIVISION, TEXTRON ELECTRONICS, INC. 96
MICRO SWITCH DIVISION, MINNEAPOLIS-HONEYWELL REGULATOR COMPANY 12
MINNESOTA MINING & MANUFACTURING COMPANY, MAGNETIC PRODUCTS DIVISION 14
MITRE CORPORATION, THE 70
MOTOROLA, INC., MILITARY ELECTRONICS DIVISION 46

PACIFIC SCIENTIFIC COMPANY, AEROSPACE DIVISION 59
PHELPS DODGE COPPER PRODUCTS CORPORATION 106-107
PHILCO CORPORATION, GOVERNMENT & INDUSTRIAL DIVISION 18
PRATT & WHITNEY AIRCRAFT DIVISION, UNITED AIRCRAFT CORPORATION 44

RADIO CORPORATION OF AMERICA, DEFENSE ELECTRONIC PRODUCTS 56-57
RADIO CORPORATION OF AMERICA, SERVICE COMPANY 13
RAYTHEON COMPANY, EQUIPMENT DIVISION 60-61
REMINGTON RAND UNIVAC DIVISION SPERRY RAND CORPORATION 100-101
REPUBLIC STEEL CORPORATION 84-85
RESISTOFLEX CORPORATION ..... 3rd Cover
ROCKET POWER INC. 97
ROHR AIRCRAFT CORPORATION 112
RYAN AERONAUTICAL COMPANY 10

SANBORN COMPANY 54
SHELL OIL COMPANY, AVIATION PRODUCTS 42
SPACE TECHNOLOGY LABORATORIES DIVISION OF THOMPSON RAMO WOOLDRIDGE INC. 122
SPERRY GYROSCOPE COMPANY DIVISION OF THE SPERRY RAND CORPORATION 64
STANDARD PRESSED STEEL COMPANY 22
STATE OF COLORADO INDUSTRIAL DEVELOPMENT 135
SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC TUBE DIVISION 50

TEKTRONIX, INC. 81
THOMPSON FIBER GLASS COMPANY, H. I. 82
TITANIUM METALS CORPORATION OF AMERICA 110-111
TRANS SONICS, INC. 135

UNITED STATES STEEL CORPORATION, NATIONAL TUBE DIVISION 103

VALCOR ENGINEERING CORPORATION 119
VICKERS INCORPORATED DIVISION OF THE SPERRY RAND CORPORATION 3

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC EQUIPMENT DEPT. 66
WOODWARD GOVERNOR COMPANY 102

ZENITH PLASTICS DIVISION, MINNESOTA MINING & MANUFACTURING COMPANY 16

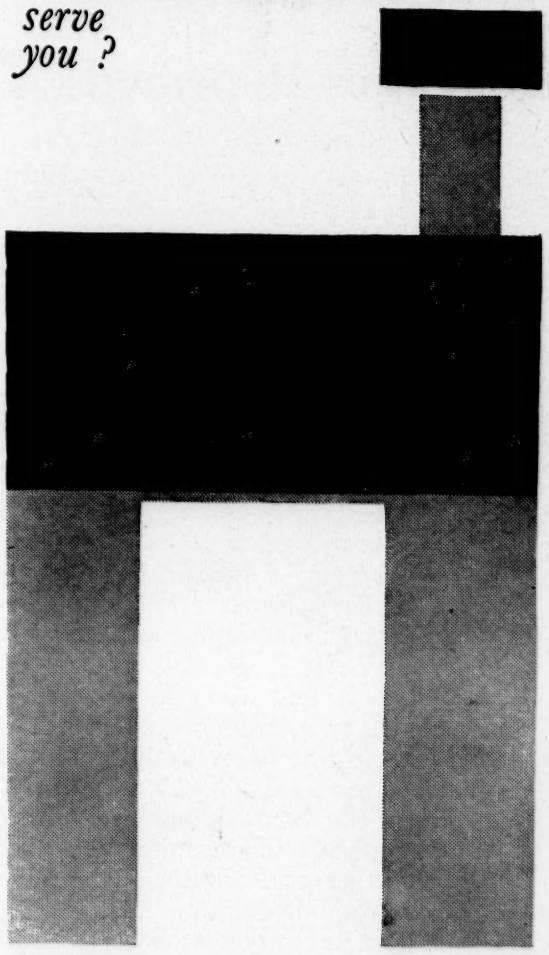
CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

WHERE TO BUY
Mitchell, Lewis & Staver 132
EMPLOYMENT OPPORTUNITIES 127-133
EQUIPMENT
(Used or Surplus New)
For Sale 134
WANTED
Equipment 134

ADVERTISERS INDEX

Boeing Co., Wichita 133
Boreas Corporation 134
Fall River Airport Commission 134
Flying Tiger Line Inc. 134
Garrett Corp. 129
GPL Div., General Precision Inc. 127
International Business Machines Corp. 130
Jet Propulsion Laboratory 128-129
Pacific Airmotive Corp. 127
Radio Research Instrument Co. 134
Republic Aviation 131
Sikorsky Aircraft 132
Solar Aircraft Co. 127
Stoltzfus Agency, Chris D. 134



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